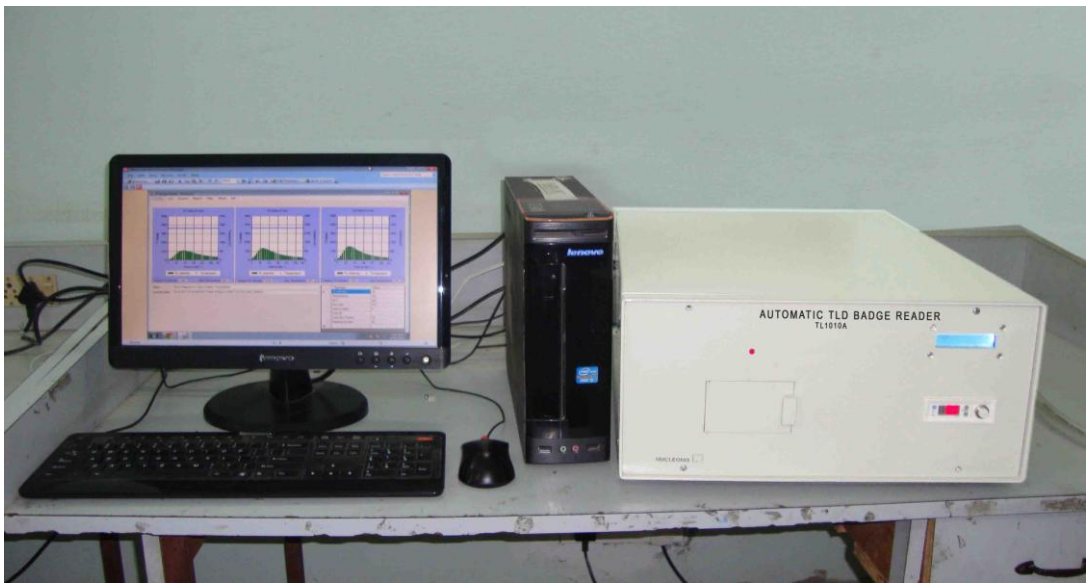
I N S T R U C T I O N

M A N U A L

AUTOMATIC TLD BADGE READER



TYPE: TL1010A

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CHAPTER – I

INTRODUCTION

The Automatic TLD Badge Reader TL1010A is a personnel monitoring system, developed & manufactured by Nucleonix Systems is primarily designed to read the TLD card (TL dosimeters) worn by radiation workers. Several Personnel radiation monitoring systems such as photographic films, pocket ionization chambers and thermoluminescent dosimeters (TLD) have been used for the routine evaluation of radiation exposures to personnel. Recently there has been a rapid increase in the use of TLD for personnel monitoring of radiation workers. The TLD systems are preferable over other systems because of several reasons such as,

a. The availability of a variety of highly sensitive TL phosphors.
b. Wide measurable range.
c. Reusability of the dosimeters.
d. Good post irradiation stability.
e. Rapid read-out capability and
f. Low cost and ease of preparation.

The TLD personnel monitoring system essentially consists of two major parts: TLD badge and the TLD badge reader.

The TLD Badge comprises of a plastic cassette containing a TLD Card made of aluminum with three Teflon TLD discs (13.3mm and 0.8mm thick) that are mechanically clipped on to circular holes (12.0mm) punched on it (52 x 30 x 1mm). Each TLD Card also comprises of a unique punched hole ID which is readout during the acquisition cycle for identifying the wearer of the TLD

This Automatic TLD Badge Reader is primarily designed to read Bhabha Atomic Research Centre (BARC) developed $CaSo_4$ (D_4) PTFE disc dosimeter based TLD cards. These cards utilize three dosimeters.

The TLD Badge Reader is designed to measure X, Gamma and Beta radiation dose. The metal filter combination (1mm Al + 0.9mm Cu) is provided to reduce the photon energy dependence of the TL discs. The TL badge reader is calibrated such that the TL output of the disc under the metallic filter reads directly the gamma radiation dose.

The TLD Badge Reader system is designed using state of art electronics, stepper motor based electro-mechanical system, embedded code and software to load and read the TLD cards for TL glow curve / dose along with personnel ID. The system facilitates entry / printout of Dose records and glow curve for the personnel. TL dosimeter is heated by hot gas (N_2) jet to 285^{o}C using a Nichrome heater assembly & TL output is recorded using PMT whose integral of the current output is proportional to the dose.

In this thermoluminescent dosimeter based personnel-monitoring system, the radiation workers wear the dosimeter & the radiation exposure is estimated on the basis of TL dosimetric reading. Thermoluminescent dosimeters make use of the property of certain materials, which absorb energy when exposed to X, Gamma or Beta radiation. On heating, the absorbed energy is released in the form of visible light. A plot of light intensity emitted against temperature is known as a glow curve. For a given heating rate, the temperature at which the maximum light emission occurs, is called the glow-peak temperature and it is characteristic, of the individual TL material (also called phosphor).

The quantity of the visible light emitted (TL output) is found to be proportional to the energy absorbed by the TL material. The estimation of radiation exposure may be based either on the height of the glow curve (differential method) or the area under the glow curve (integral method).

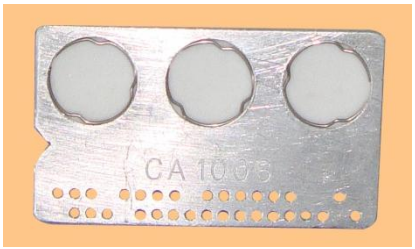
Accessories :

1. Light Source Card
2. TLD Card
3. Cassette
4. Magazine
5. Nitrogen Cylinder
6. Gas Regulator

Front View

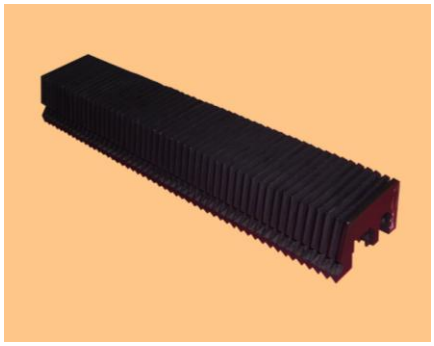
Rear View

Light Source card



TLD card

TLD cassette



TLD Magazine

Gas Regulator

Nitrogen Gas Cylinder

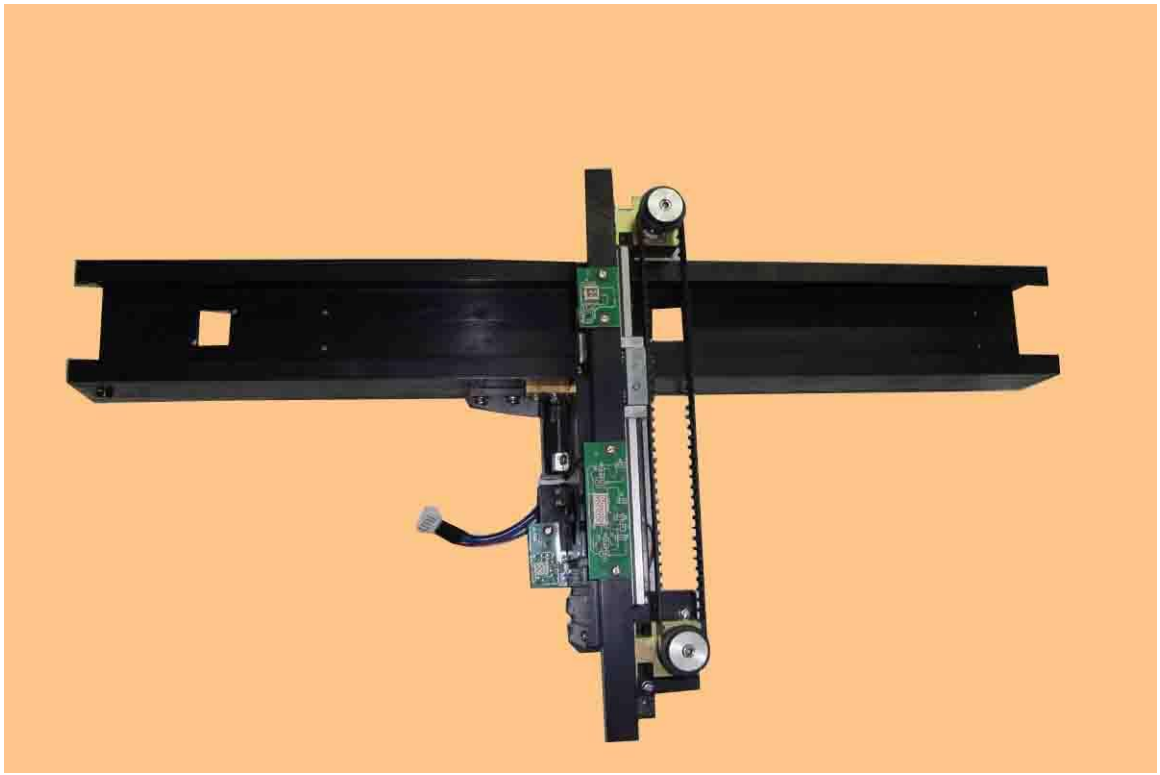
CHAPTER - II

IMPORTANT IMPROVEMENTS & MAJOR DESIGN CHANGES INCORPORATED IN AUTOMATIC TLD BADGE READER SYSTEM

- Digital flow rate meter indication is provided for checking flow failure
- Precision stepping motors are used for (a) Disc positioning (b) Magazine movement.
- Digital Linear actuators are used for TLD Card raise and PMT shutter control
- PC Based design with smart hardware diagnostics using a microcontroller based design
- All PCB interconnections across PCBs are through mother board for minimal wiring and better reliability
- SMPS power supplies are used to achieve minimum size
- Highly reliable and precise electro-mechanics, to eliminate any TLD card positioning errors
- Front panel LCD display for local indication of fault diagnostic messages

Auto TLD reader setup with PC & Nitrogen gas cylinder adjacent

Top inside view of the Automatic TLD Badge Reader



Magazine channel assembly with stepper motor drive system

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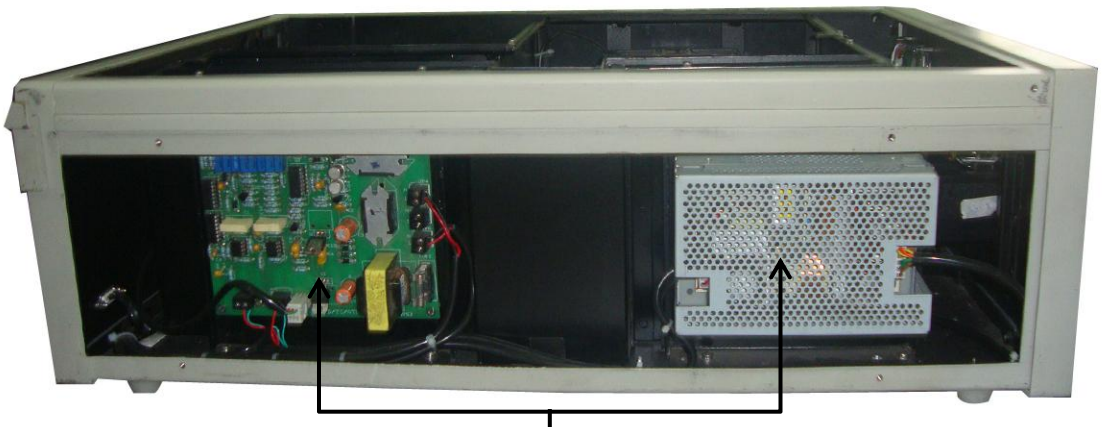
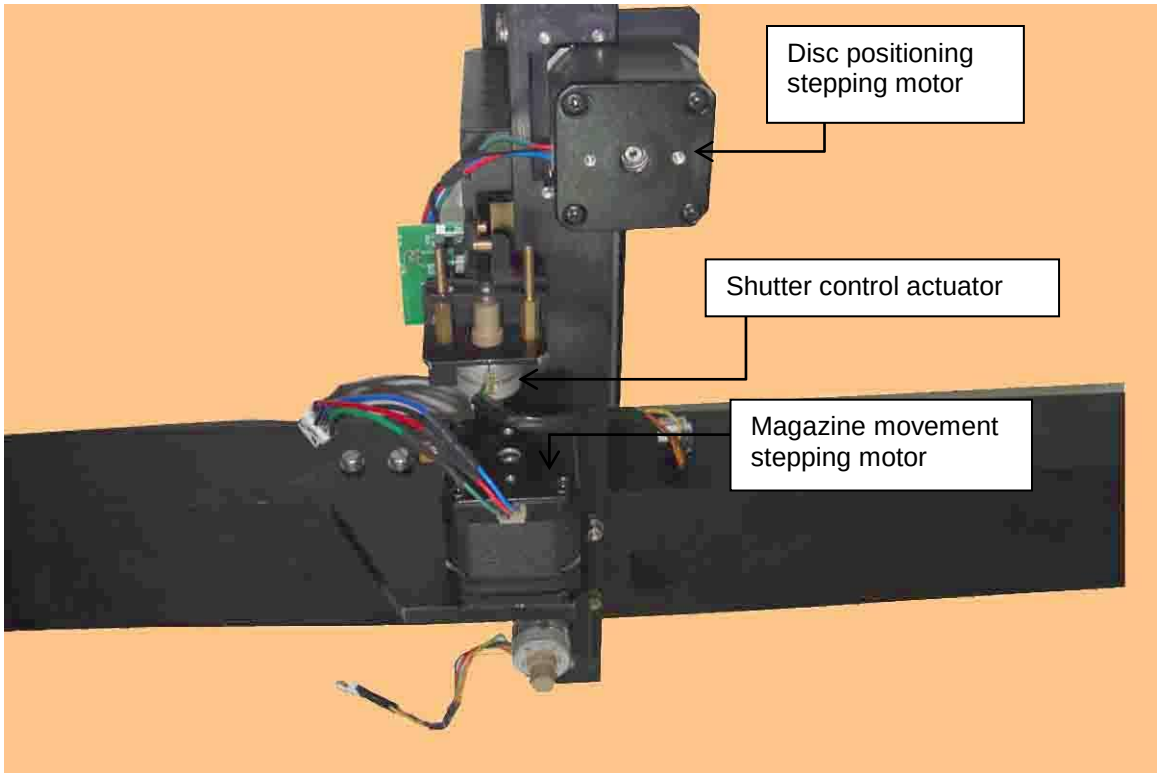
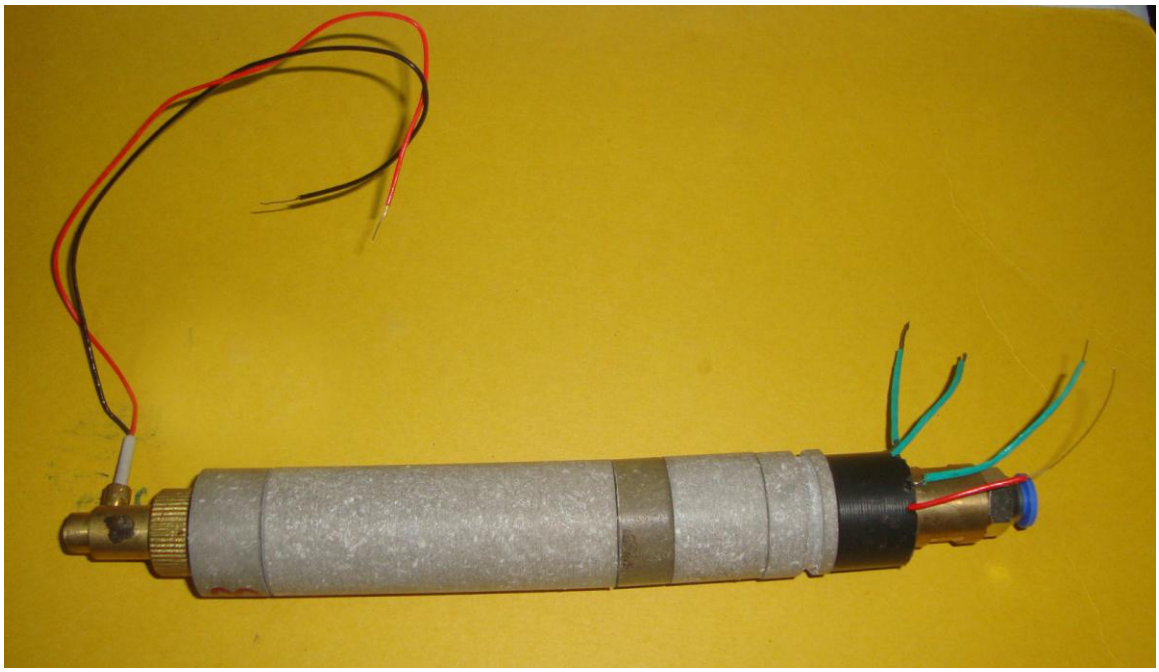


SMPS power supplies are in this design resulting in no use of bulky power transformers



High precision stepping motors have been used in this design.

1. Temperature Controller PCB
2. Controller PCB
3. Motor Driver PCB
4. Mother board (most of the inter PCB wiring is through mother board)



Heater assembly

Magazine loading door

Digital flow rate meter

LCD dot matrix display (16x2) status LCD display indicates, (card position, Temperature OK, EHT OK, Flow rate etc.)

CHAPTER – III

SPECIFICATIONS

Dosimeter	**:**	Three-element BARC $CaSO_4$ (Dy) PTFE disc dosimeter badge with personnel ID.
Light Measurement System	**:**	Photo-Multiplier tube (EMI 9125B-bialkali) Light measuring system (LMS).
Dark current	**:**	Dark current is 1μSv ($CaSO_4$) equivalent with software-based sampling & subtraction.
Heater Element	**:**	Nichrome heater assembly.
Heating Method	**:**	Hot gas (N_2) heating
Nitrogen flow rate measurement	**:**	Digital flow rate meter
Heating Cycle	**:**	The temperature is raised to 285°C in 8 sec and clamped at 285°C
Dose Range	**:**	50μSv-5Sv (Gamma) and 100μSv-5Sv (Beta)
Dose Threshold	**:**	<50μSv
Readout time	**:**	Approx 100 sec per badge
Residual Signal	**:**	≤10% of reading
Facilities Available	**:**	Entry of calibration factor, etc. Storage of dose and glow curve data of badges in Hard Disk. Stepper motor driver assembly for automatic feeding of 50 dosimeter cards loaded in a magazine.
Software	**:**	Windows 7 (32 bit) / XP-SP3 compatible software facilitates storage and display of glow curves, computations of dose & generation of dose reports, transfer of data to user defined file, etc.
Temperature Monitoring	**:**	Chromel-Alumel thermocouple in hot gas stream.
Range Selection	**:**	Automatic
Calibration	**:**	Coarse adjustment by varying the EHT through a potentiometer in the EHT circuit.
Safeguards	**:**	Heater / Gas flow / EHT / Card ID failure: The heater temperature, gas flow rate, card ID and EHT are checked for failure in every dosimeter readout cycle. In the event of failure of heater or gas flow rate or EHT or card ID, the readout is terminated and a message indicating corresponding failure message is flashed on the PC monitor.
Mechanical Failure and failure message	**:**	Any mechanical failure during readout cycle is sensed online & cycle is terminated with an option for the user to restart the cycle. EHT or the input circuit (I-F converter) is sensed and reading cycle is terminated in case of failure.
Nominal Power Supply	**:**	Power supply: 230V, 50Hz: Power requirements: 500VA (max including PC)
Minimum PC Requirements	**:**	Intel Core 2 Duo 2.8 GHz Intel G31, 2GB DDR2, 500 GB SATA, internet ready optical scroll, 19" TFT monitor, Windows 7 Licensed OS CD & LaserJet printer (Monochrome).
Applications	**:**	Personnel monitoring of radiation workers in Nuclear power stations, Isotope laboratories, Industrial radiography installations, diagnostic & therapeutic radiology centers, etc.

CHAPTER – IV

INSTRUMENT BLOCK DIAGRAM & DESCRIPTION

4.1. Automatic TLD Badge Reader is specifically designed to measure TL output of the discs fixed on to the card along with the personnel ID. It utilizes the integral method of TL measurement as it involves less stringent requirements on heating rate. The reader basically provides a programmed heating cycle to the TL dosimeter and senses the instantaneous light emitted by the dosimeter (glow curve signal) and displays the total integrated light output in terms of μSv (unit of equivalent dose).

4.2. CONTROLS

The mechanical assembly & the microcontroller based control circuits are housed in the instrument enclosure. Apart from a digital flow meter with a control knob for the adjustment of the gas flow and a 16x2 character LCD display for status information the instrument panel does not have any operating controls. All the operations are carried out from the PC connected to the instrument through a USB link. The status indication LCD indicates the instrument ON status.

4.3 BLOCK DIAGRAM & SYSTEM DESCRIPTION

As the block diagram shown indicates, this product is a PC based system where the primary commands are issued to a micro-controller board through USB port (Virtual communication port is used). Based on the commands issued, the micro-controller responds accordingly by executing the required function and sends back acknowledgement code.

The system essentially comprises of the following:

a. Stepper & DLA motor based Electro-mechanical system along with optical sensors for precise noise-free motion & feedback
b. SS tube based gas heating assembly along with digital flow measurement system.
c. Photomultiplier Tube, along with heat absorbing glass as a light measurement system.
d. Data acquisition & control circuits comprising of micro-controller circuits, heater controller circuits, high voltage module, I to F convertor module, Stepper / DLA motor drivers module & LV power supplies. Majority of the circuits are EURO type PCBs sitting on a mother board PCB. This facilitates easy maintenance in the event of breakdown.
e. Personal Computer (PC) system with TLD data acquisition analysis & report generation software.

Stepper / DLA motors & driver units:

The magazine positioning is controlled by a stepper motor based on the feedback received from the 4 optical sensors underneath the magazine.

The optical sensors sense the grooves made on the magazine which generates signature code for home position & each channel advance. Using this method, precise noise-free positioning at any of the 50 positions can be done.

Once positioned at a specific card location, the TLD card can be raised by using the card raise DLA motor for taking readout of the current card.

In the next step, the card is drawn through a optical sensor arrangement so that personnel ID can be readout. This is followed by positioning at D1, D2 or D3 positions using the belt drive stepper motor. Before acquisition can begin for a TLD card, the shutter can be opened using shutter DLA motor. After this acquisition begin.

Using the above motors positioning for readouts TLD card and personnel ID are done.

Temperature controller board design requirement :

The design principle of the system is that the temperature should rise to 285^{o} C within 10-12 seconds and remain clamped till completion of 30 seconds in disc read mode. So that the temperature of the disc goes upto 285^{o} C.

To raise the temperature of the disc to 285^{o} C. The air thermocouple should attain 12mV (44 mV/^{o}C Cr-A1,K-type thermocouple) in a leakage free air path. The TL disc emits the glow curve peak at 240^{o}C. But for getting maximum glow curve emission the TL Disc is heated upto 285^{o}C.

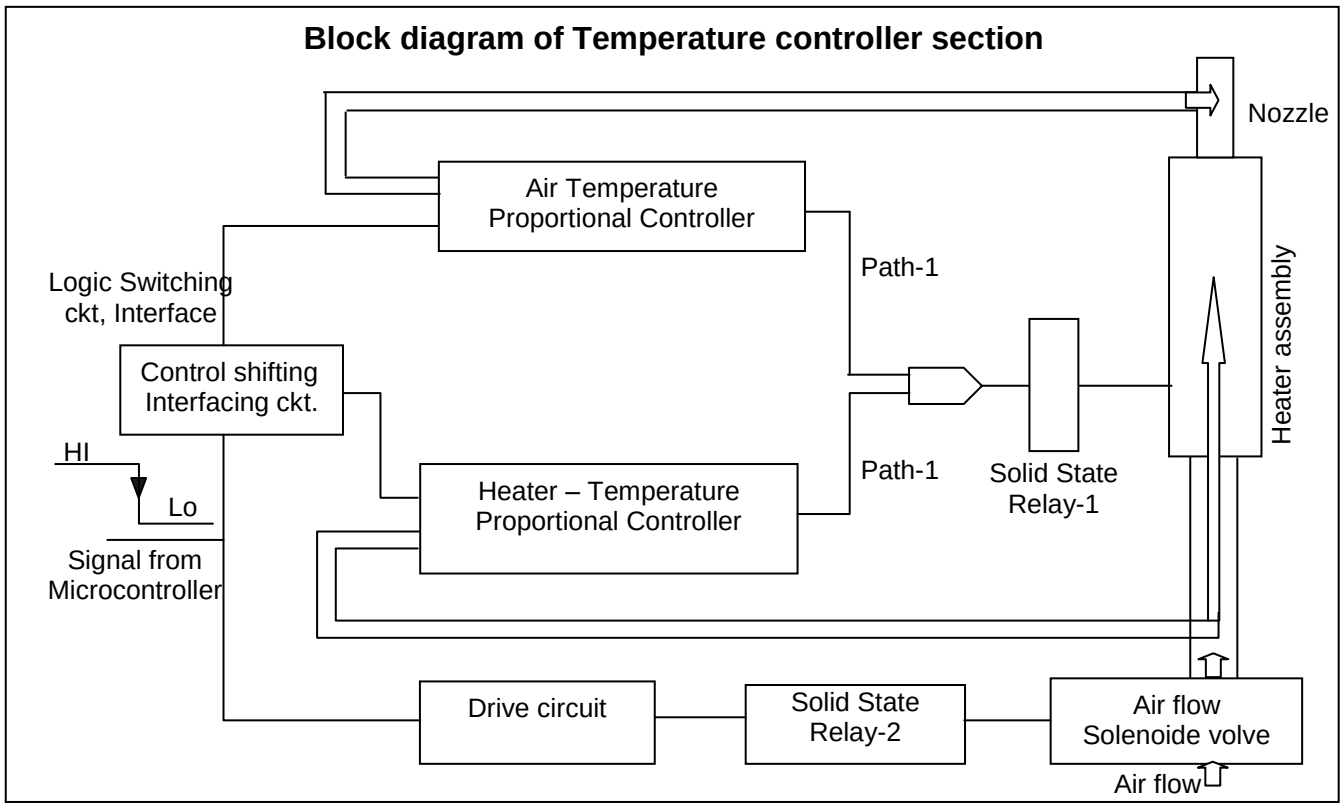
The temperature controller board is designed to meet the above requirement. It is a dual proportional temperature controller. The purpose of using two proportional controller is to optimize the temperature of heater in case of idle state. And to increase the temperature of heater in case of readout state. Two feed back thermocouples are provide for each proportional controller. To simply the explanation the one proportional controller having heater thermocouple feedback is termed as heater temperature controller and the other one having air thermocouple is termed as air temperature controller and the other one having air thermocouple is termed as air temperature controller. When the system is in readout state solenoid valve switched ON and the temperature of the heater is controller by the feedback from air thermocouple. And when the system is in idle state the temperature of the heater is controlled feedback from the heater thermocouple. The signals from microcontroller switches the controls in between the two proportional controllers as well as regulate air flow.

The problem in the temperature section of the TLD system may be due to solenoid malfunctioning, thermocouple wires and heater element breakdown and leakages in the path and loose connections leeding to irratic switching of solenoid volve.

In case of breakdown replace the faulty component with new one in heater assembly. In due course of time TC board may have to be calibrated. If there is a variation observed in the readings.

On receiving the command (HI to LO signal) from the microcontroller, through transistor driver circuit solid state relay (SSR2) opens solenoid volve to all Nitrogen gas to flow through the flow system consisting of Digital flow meter & is let into Heater assembly.

Block diagram of Temperature controller section



1. **With readout cycle ON:**
   Initially the Heater set point at this stage will assume 6000 & through this (path-2) relay (SSR-1) goes ON & AC mains power is up rapidly.
   With gas flow being on now, gas gets proportional band, resulting into proportional band making SSR-1 ON/OFF through path-1. Thus temperature controller controls gas temperature constant during readout cycle for 30sec of disc exposure or 30X3 sec for the card exposure time.

2. **When the Dosimeter readout is not ON:**
   Heater set point will be 190^0 C. Pulse width modulator control ON/OFF of the SSR-1, to regulate the heater temperature to 190^0C. During this time gas flow is cut-off & hence gas temperature is LOW. Air flow path proportional controller comparator will be outside the proportional band & path-1 controls signal is OFF. Temperature controller through controls the heater temperature.

3. **Heater Assembly:**
   Heater assembly consists of a ceramic tube into which Nichrome heater coil is passed. This heater is pushed into a steel tube. Over this syndania tube is covered for greater insulation. At hot end of the heater coil there is air thermocouple mounted to measure hot Nitrogen temperature & in the middle of the heater ceramic tube toward hot end at (2/3) distance from cold end heater thermocouple is placed. Nichrome heater coil terminals & thermocouple terminals are all fixed onto a terminals block.

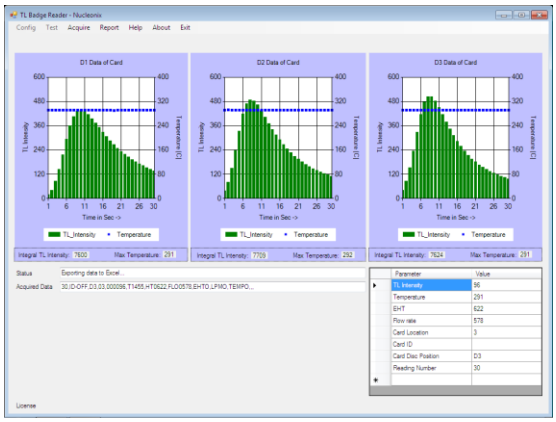
Photomultiplier Tube :
9125B PMT of ETL is used for detection of the light signal. The light signal is converted to proportional current signal by the PMT.

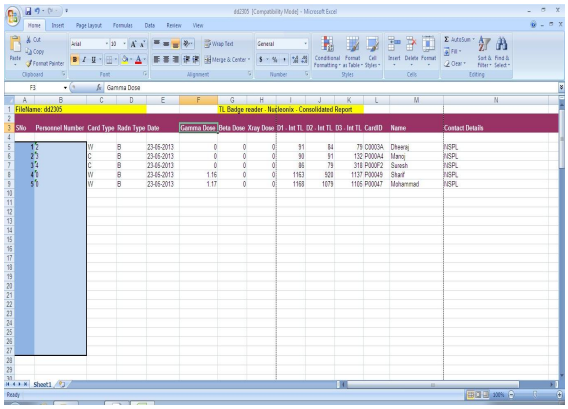
Data acquisition & control circuits :
The Data acquisition & control circuits are powered by 1 no. of SMPS supplies generating +5V, +/-12V respectively. The heater assembly is powered by a separate linear transformer mounted on it. The other SMPS powers rest of the electronics like digital circuits, analog section, stepper motors, high voltage etc.
The data acquisition and control unit essentially comprises of a micro-controller board at the heart which essentially controls all hardware during acquisition or otherwise. Micro-controller receives commands from PC based on which it responds. It works in slave configuration with PC. Micro-controller board generates signals for precise motion of stepper and DLA motors based on optical feedback received from corresponding optical sensors during data acquisition. The following movements are controlled by the micro-controller – Magazine Eject / Home, Magazine move option, Card raise / lower, card position Home / D2 / D2 / D3, shutter Open / close by the aid of optical sensors. Once positioning is complete, the acquisition of TL card / light source card / Dark current is done by the micro-controller. Before acquiring for TL card, the solenoid & heater controller are turned ON to enable gas heating upto 285^oC. Once gas temperature is reached, the TL card is moved to position D1 or as selected and acquisition is carried out. After each disc readout, card is moved to next disc position & acquisition repeats for that disc. After all readouts are completed solenoid & heater are turned OFF automatically. All the above motors are driven by stepper driver modules located on stepper drive card based on signal received from micro-controller. The PMT is biased by a miniature HV module located on the mother board. The PMT o/p is processed and converted to frequency o/p by a I to F convertor module which is located in the micro-controller board.

A Ni63 based Light source TLD sized Card is provided separately which can be used for stability check of the PMT during the acquisition cycle. A light source check command may be issued after pausing acquisition cycle to check for stability. The Light source TLD card has to be placed in Magazine Position 1 before carrying out light source check and after acquisition it has to be removed before proceeding for personnel dosimetry.

PERSONNEL COMPUTER SYSTEM WITH SOFTWARE FOR TL BADGE READER :

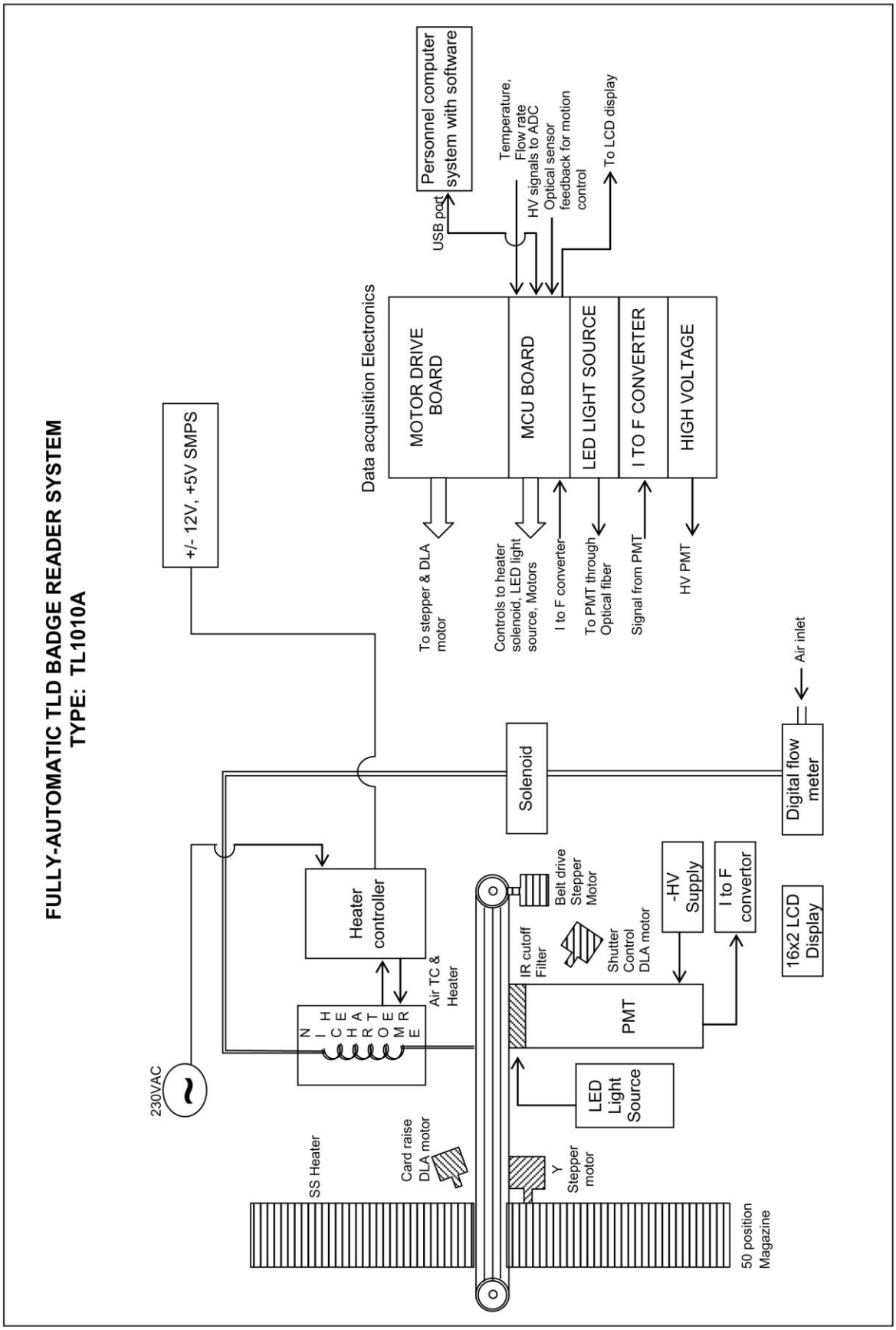
Personnel computer system loaded with the software for TL Badge reader serves as comprehensive 'TL Dose records management software'. It is user-friendly, reliable and feature rich. It has powerful fault diagnostics reporting capabilities.
Typical PC configuration can be as given below;
Intel Core 2 Duo 2.8 GHz Intel G31, 2GB DDR2, HD, Windows 7 Licensed OS (32 bit) & Printer





Key features of Software:

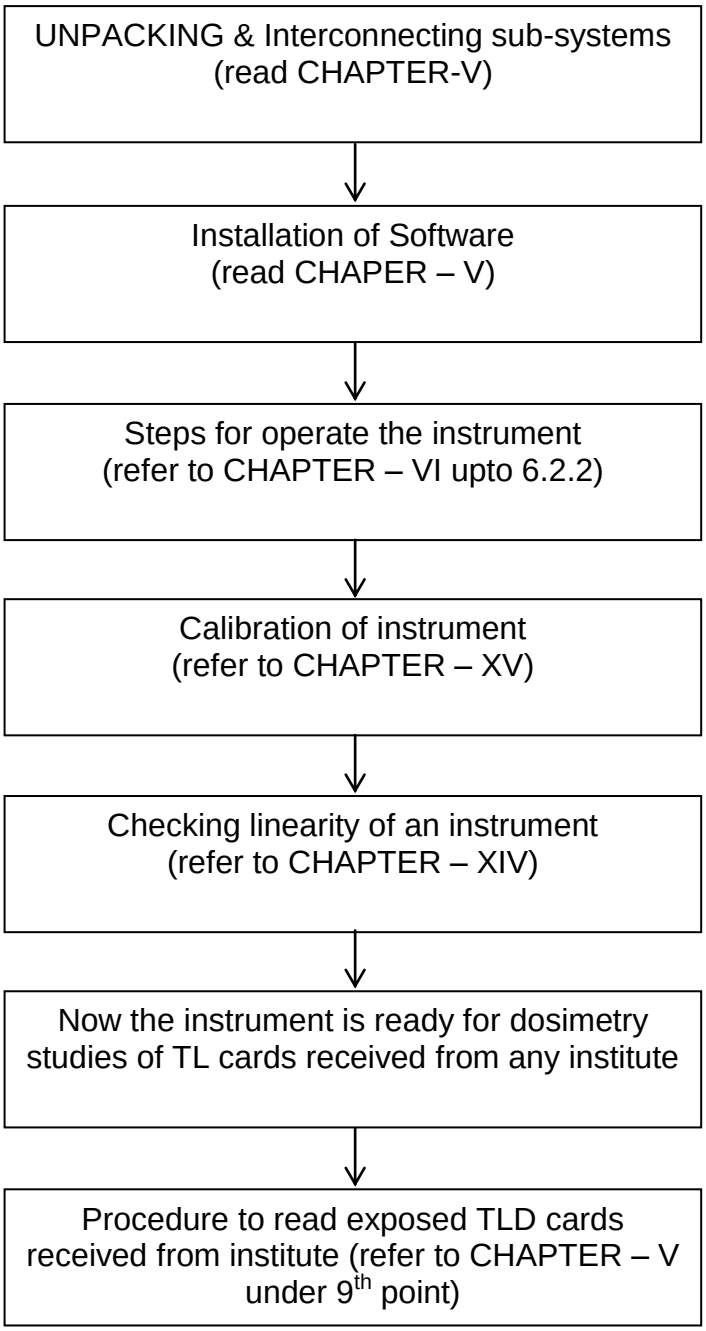
- Provides Commands for complete fault diagnostics of the Reader that includes checking of Light Source, Dark Current, Heater, Gas flow, EHT, Mechanical movements.
- Provides screen to enter Institution, Personnel and Card details prior to acquisition.
- Acquisition of up to 50 cards can be done in one go.
- Acquisition can be paused & resumed without any loss of data.
- Fault checks are performed during acquisition and reported to user.
- Calibration factors for Reader and D1, D2, D3 positions can be set.
- Dose calculator is provided for calculation of Dose by manually entering Integral TL values for D1, D2, D3 positions.
- Glow curve data is stored in Text file and can be optionally exported to Excel.
- Glow curve data can be viewed at a later data individually for each card.
- Dose values for each card, Personnel numbers are written to a batch file.
- Dose information can be optionally written to Nucleonix Dose Records management database and User wise Cumulative Dose reports can be generated.
- All TLD cards are enrolled into the database before issue to the user along with dosimeter ID information.
- Before acquisition, all cards are scanned for auto identification and reporting of full personnel information.
- After acquisition, reports of dose information is tagged to the corresponding user having corresponding TLD.


FULLY-AUTOMATIC TLD BADGE READER SYSTEM
TYPE: TL1010A
Personnel computer system with software
USB port
Temperature, Flow rate
HV signals to ADC
Optical sensor feedback for motion control
To LCD display
Data acquisition Electronics
MOTOR DRIVE BOARD
MCU BOARD
LED LIGHT SOURCE
I TO F CONVERTER
HIGH VOLTAGE
+/- 12V, +5V SMPS
To stepper & DLA motor
Controls to heater solenoid, LED light source, Motors
I to F converter
To PMT through Optical fiber
Signal from PMT
HV PMT
Air inlet
Solenoid
Digital flow meter
Heater controller
Air TC & Heater
Belt drive Stepper Motor
IR cutoff Filter
Shutter Control DLA motor
-HV Supply
I to F convertor
16x2 LCD Display
PMT
LED Light Source
230VAC
SS Heater
Card raise DLA motor
Y Stepper motor
50 position Magazine

CHAPTER – V

INSTALLATION AND SETUP

Flow chart for installing, operating, calibration & using system for personal monitor of TLD cards for dosimetry studies.


UNPACKING & Interconnecting sub-systems
(read CHAPTER-V)
Installation of Software
(read CHAPER – V)
Steps for operate the instrument
(refer to CHAPTER – VI upto 6.2.2)
Calibration of instrument
(refer to CHAPTER – XV)
Checking linearity of an instrument
(refer to CHAPTER – XIV)
Now the instrument is ready for dosimetry studies of TL cards received from any institute
Procedure to read exposed TLD cards received from institute (refer to CHAPTER – V under 9th point)

i) **Choosing a place for installation:** Find a flat, firm surface with enough room to put the TLD Badge Reader unit along with the Personnel Computer and a Printer. The entire place must be clean and free from dust and air-conditioned so that the temperature is around 25°C. Do not operate any noisy equipment near the reader system. Provision should be made for installing a N_2 gas cylinder on the right side of the reader. (refer to photographs indicated in this CHAPTER-III, as you read it)

ii) **Procedure for assembling the reader system:** The back panel of the reader unit is provided with a 9 pin D connector for connecting the reader system to a USB port of a Win XP / Win 7 based system.

Ensure that the USB drivers are installed by TLBadgeReader.bat file. Connect the communication cable from TL Badge Reader Electronic Unit to PC USB port. TL Badge reader provides a virtual USB connectivity to PC. This means that the USB will appear as a COM port on the PC. For establishing connectivity with the reader, COM port number corresponding to this connectivity must be identified. To do this, Right click on “My computer” icon on Desktop. Select Properties -> Device Manager -> Ports. You will find the COM port number. For e.g. If you find “COM3”, it means that COM port number is 3.

iii) A gas inlet is also provided on the back panel of the reader unit. Connect a Nitrogen cylinder with the tube provided to the gas inlet of the reader unit. Set the pressure at 2 kg/cm^2 in the pressure gauge.

iv) **PC installation:** The minimum required computer configuration is computer system (Branded) with Intel Core 2 Duo 2.8 GHz Intel G31, 2GB DDR2, 500 GB SATA, internet ready optical scroll, 19” TFT monitor, Windows 7 Licensed OS CD & LaserJet printer install the PC and printer with the standard procedure given in PC user's guide. **Win XP 64-bit is currently not supported by the system.**

v) **Software installation:** To install the software, execute TLBadgeReader.bat in the installation CD. Follow instructions in Readme file. Click through the options, until you get the message that installation is completed successfully. In case of any errors, please take a screenshot of the error message and email to Nucleonix Customer Support.

vi) **Digital Flow meter:** At the time of installation, Ensure that the flow control knob provided on the Digital Flow meter is turned fully clockwise. Turn the knob slowly to anti-clock direction to maintain the flow rate in the range of 5 – 6 lpm when gas flow is ON.

vii) **Power Supply Connections:** Connect the reader unit and computer to the power supply (230V, 50Hz). To provide protection to the reader system from spikes in the supply line, take the power supply connections through a spike buster. It is advisable to use a 500 VA un-interruptible power supply (UPS) for the Automatic TLD reader system including the PC to ensure data integrity in the event of a power failure.

Starting the Program: Switch on the computer, Click on Start -> Programs –> Nucleonix Systems -> TLBadgeReader or Double click TLBadgeReader icon on Desktop to run the application. Then the software of TLD Badge Reader will be displayed on the PC monitor. The program details are discussed under SOFTWARE chapter, and the working is discussed under 'INSTRUCTIONS FOR HARDWARE/ SOFTWARE'.

viii) **Switching the Reader System:** Make sure that the Nitrogen cylinder is connected to the gas inlet of the reader unit. Now, switch on the reader unit. The reader should be switched on at least 30 minutes before the reading operations to allow for the stabilization of PMT and rest of the electronics.

ix) **Procedure to read exposed TLD cards :**

- On receiving the TLD cards from an institution, take out TLD cards from the cassettes, lable them, arrange them orderly.
- As the instrument is already calibrated, start "prepare reader" through software. Refer to CHAPTER-VI under 6.2.3.There you can check Light leakage, heater and light source.
- Load the TLD cards in magazine and enter the card details through software.
- Place a **control card** in magazine first position.
- Start acquisition – refer to CHAPTER – VI under 6.2.3. *Start* point.
- After completion of acquisition a message window appears as **'Acquisition completed'**. All data saved in reports as per file name given.
- Finally evaluate dose as per your dose evaluation procedure.

CHAPTER – VI

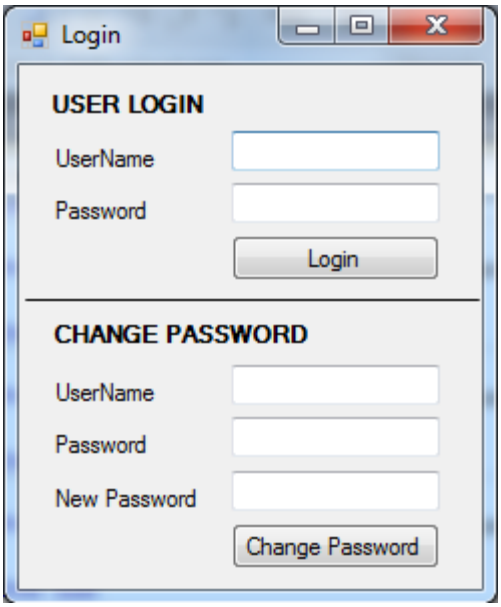
OPERATING INSTRUCTIONS FOR HARDWARE/ SOFTWARE

Switch on the computer, Click on Start -> Programs –> Nucleonix Systems -> TLBadgeReader or Double click TLBadgeReader icon on Desktop to run the application. Then the Login Screen as shown in 6.1 appears on the PC monitor.

6.1 LOGIN SCREEN

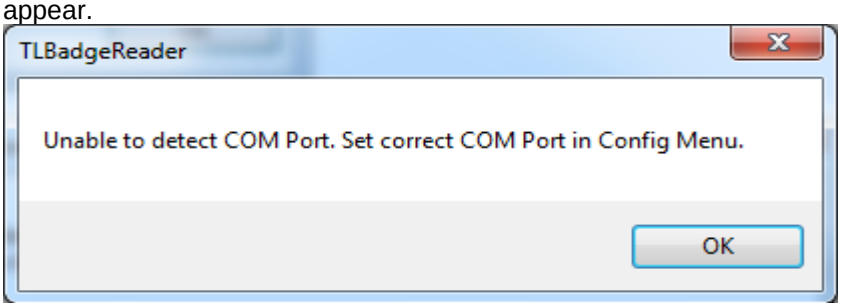
Once Application is invoked as described in Chapter V, the application starts and a Window as show below appears

Enter “admin” as Username, “Nucleonix” as password and click on Login button. This password can be changed to User’s choice, using the controls on lower part of the screen.



6.2 SOFTWARE OPERATION AND FEATURES

After Login, software performs certain checks before displaying the main screen.
The first check is **COM port check**. If COM port settings are incorrect, then following windows appear.

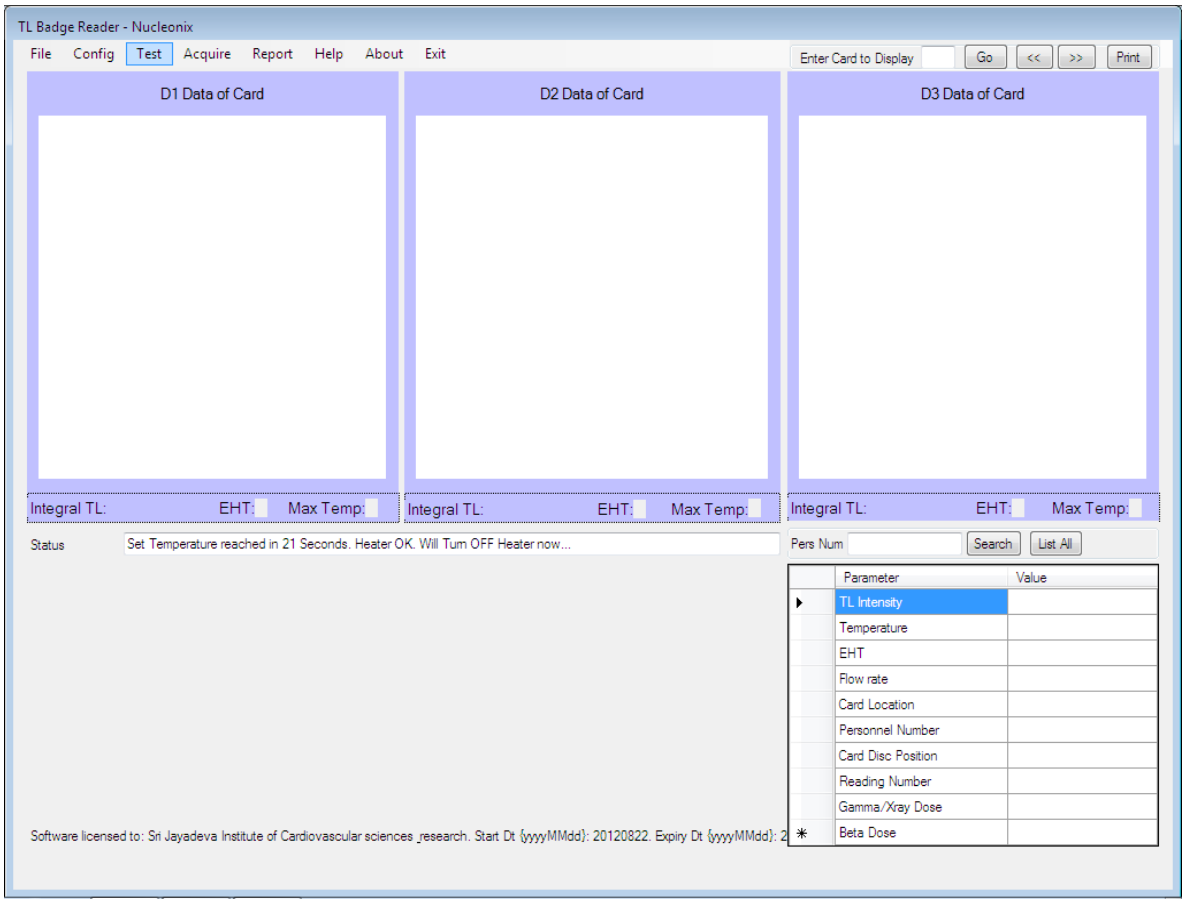


Main screen of the software is displayed after user clicks on Ok button.
Recheck the COM port number and enter the correct COM port number in ”Config-> Set COM Port“ menu.
If COM port number is correct, the software then **checks for the Reader response**. If Reader is not detected, appropriate message is displayed and Main screen of the software is displayed.

Test and Acquire Menu commands cannot be used until correct COM port is set and Reader is detected.
If reader is detected, the magazine is automatically ejected. This time user has to load the cards in magazine, insert magazine into the reader and close the door.

Caution: User must not pull or push the magazine while Reader is On. This might cause mechanical damages.

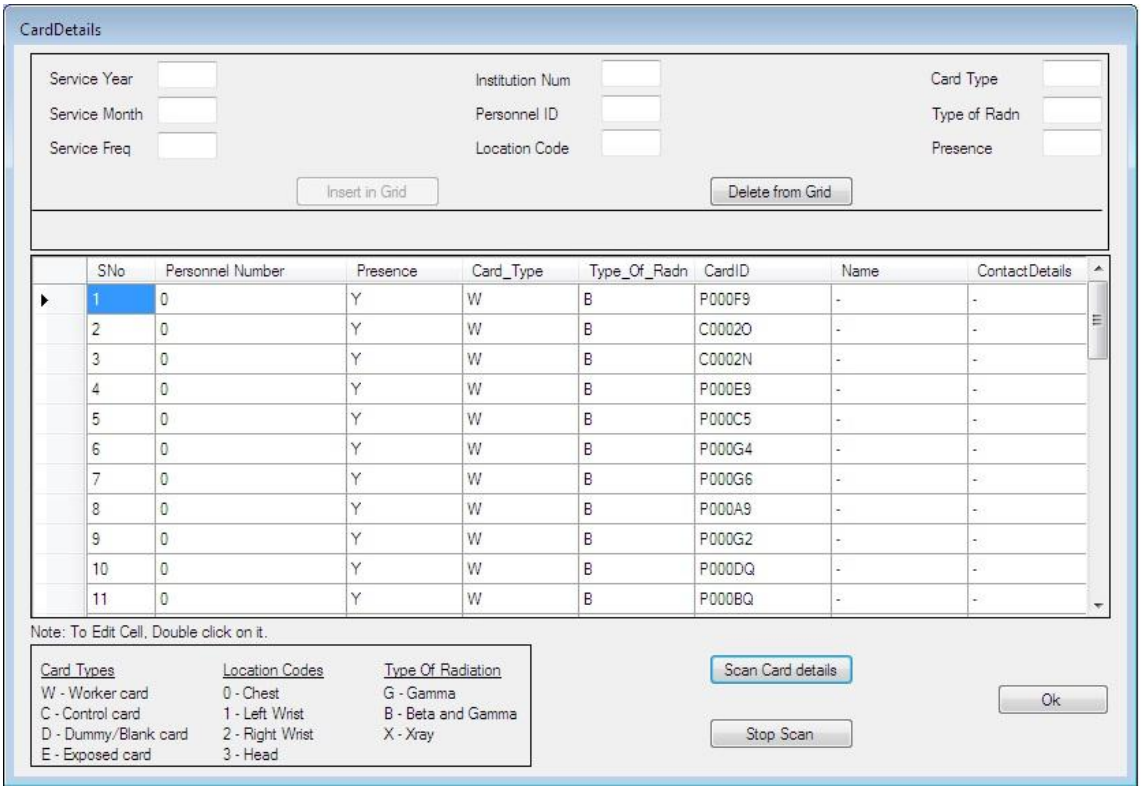
The main screen of TL Badge Reader appears as below:



6.2.1. CONFIG MENU

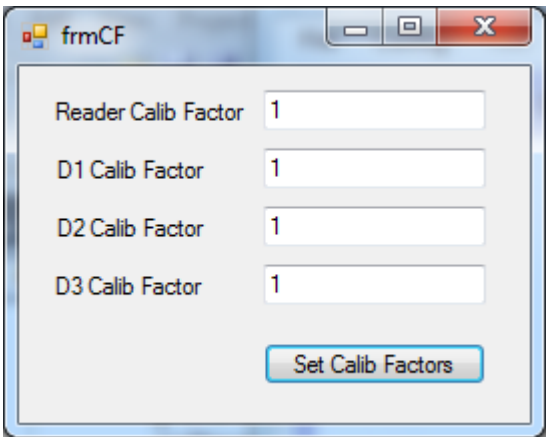
Setting the COM Port
To set COM port, select Config menu and click on “Set COM port“. In the window that pops up, enter the COM port number and click Ok. The application is terminated for the new settings to take effect. Now Run the application again.

Setting the Card details (Semi-Auto mode of operation)
User needs to provide the card details for the cards to be loaded into the magazine. To do this, user must click on “Config Menu and “Set Card Details. The below window will appear



Various card details like Institution Number, Service Year, Month, Frequency, Personnel ID, Location code (Chest / Left or Right Wrist / Head), Card type (Worker card/ Control card / Blank card / Exposed card), Type of Radiation (Gamma / Beta / X-ray) can be entered. „Presence" indicates whether card is physically being loaded or not. Clicking on "Insert" button will adds the card to the list.
This process is to be repeated for each card. User needs to finally click on "Ok".
Note that these details are stored in memory. In case user exits the application, these details are lost. This feature is particularly useful for users who receive cards from multiple institutions in batches.

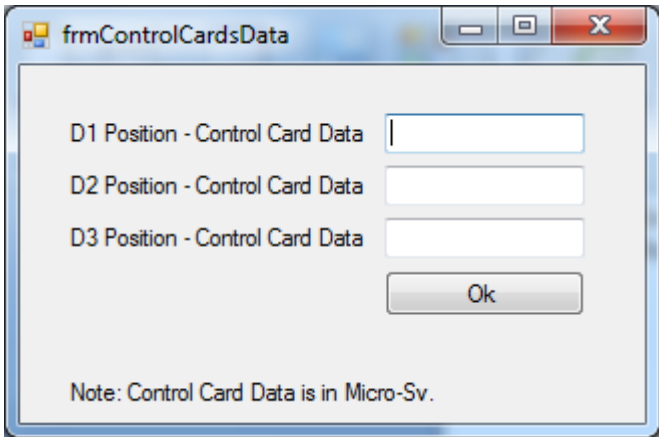
Setting Calibration Factors
Software provides the facility to set Calibration Factors for D1, D2, D3 data as well as Reader Calibration Factor for the purpose of normalization of data



By default all the values are set to 1. These factors are multiplied with each acquired data point and plotted.

Setting Control Cards Data

Initial few cards that are loaded into the Magazine are normally Control cards. The data obtained from these cards will be utilized for Dose calculations. Hence, User must first acquire data from these Control cards by clicking on “Acquire” Menu and “Start”. Once Control cards data is obtained, User must click on “Stop” to stop the acquisition and note Control cards data. This must be entered in the below form by clicking on “Config” Menu and “Set Control Cards data”.


frmControlCardsData
D1 Position - Control Card Data
D2 Position - Control Card Data
D3 Position - Control Card Data
Ok
Note: Control Card Data is in Micro-Sv.

Turning ON/OFF ‘Export data to Excel’ option

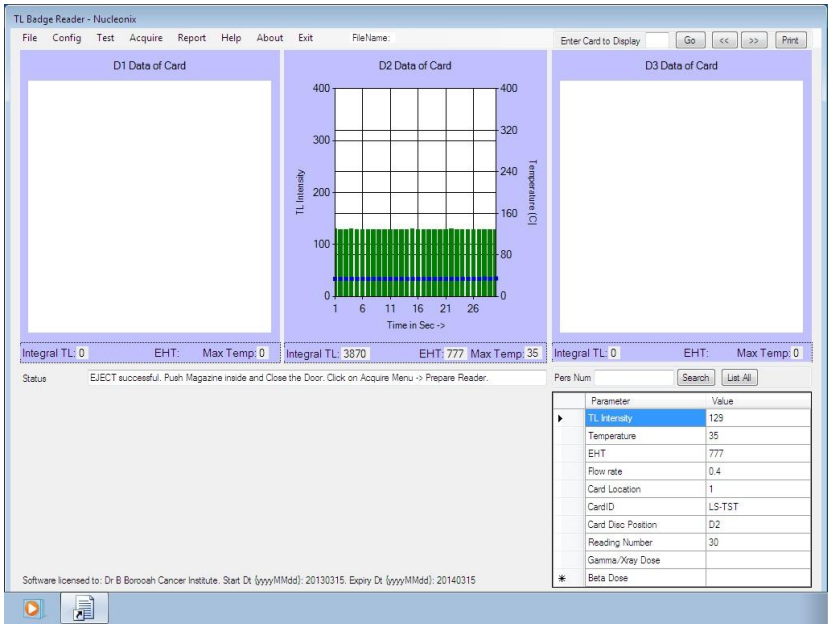
Data can be exported to Excel by turning the “Export to Excel‟ option ON. This can be done by clicking on “Config” Menu, “Data Export to Excel” and “ON”. However, this will add some additional time to the acquisition cycle.

6.2.2. TEST MENU

Prior to acquisition, user can conduct various checks on TL Badge Reader hardware. Though they are not mandatory, the checks can indicate any faults prior to acquisition.

Check Light Source Mode

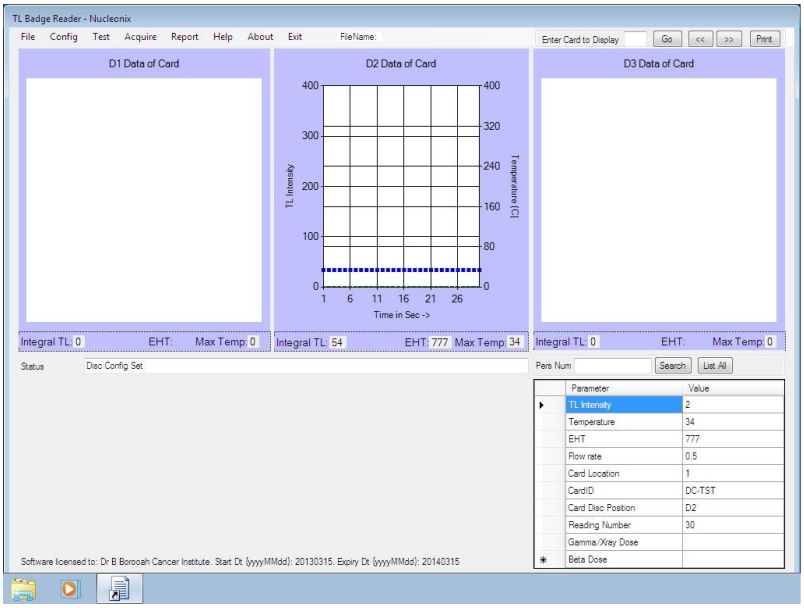
User has to place Light source TLD card in position 1 in magazine. A constant light output is generated by a Light source TLD Card. This signal is acquired and plotted. Light source is physically mounted on D2 position of the TLD Card. Typical data is shown in the figure below:



After completion of Light source test user has to remove the light source card from magazine before proceeding for dosimetry to prevent accidental damage to the light source by heating

Dark Current Mode

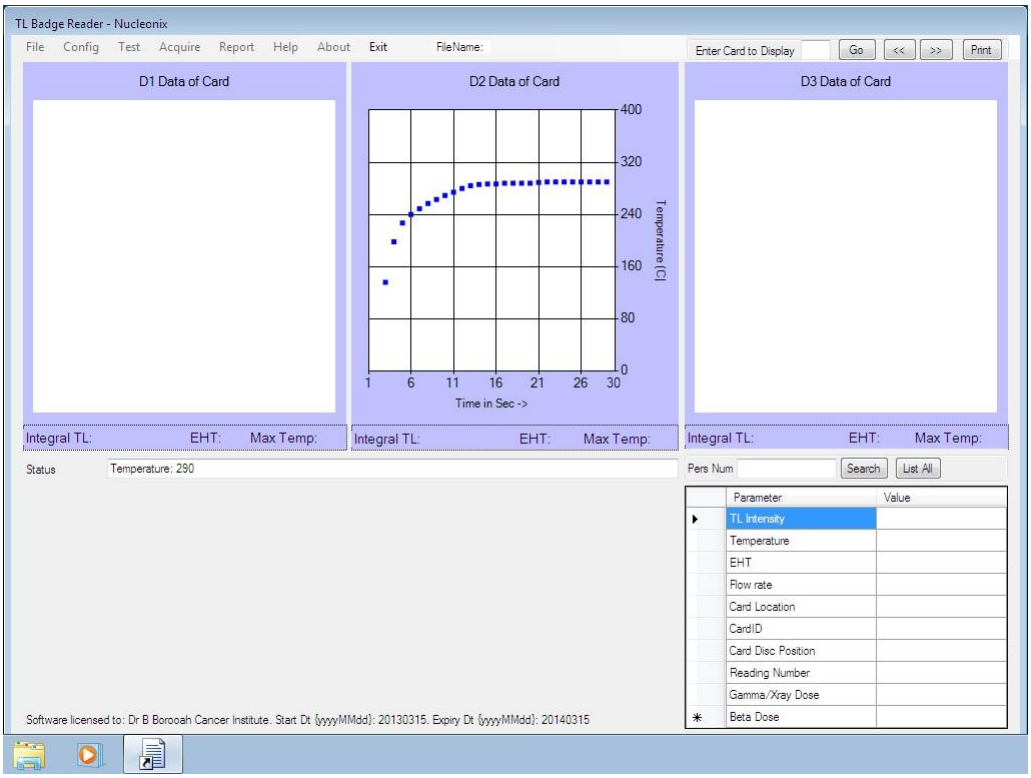
In this mode, Light Source is turned OFF, shutter is Open and Heating is OFF. Dark Current data is acquired and plotted. Typical data is shown in the figure below:


TL Badge Reader - Nucleonix
File Config Test Acquire Report Help About Exit FileName:
Enter Card to Display Go << >> Print
D1 Data of Card
D2 Data of Card
D3 Data of Card
TL Intensity
Temperature (C)
Time in Sec ->
Integral TL: 0 EHT: Max Temp: 0
Integral TL: 54 EHT: 777 Max Temp: 34
Integral TL: 0 EHT: Max Temp: 0
Status Disc Config Set
Pers Num Search List All
Parameter Value
TL Intensity 2
Temperature 34
EHT 777
Flow rate 0.5
Card Location 1
CardID DC-TST
Card Disc Position D2
Reading Number 30
Gamma/Xray Dose
Beta Dose
Software licensed to: Dr B Borooah Cancer Institute. Start Dt (yyyyMMdd): 20130315. Expiry Dt (yyyyMMdd): 20140315

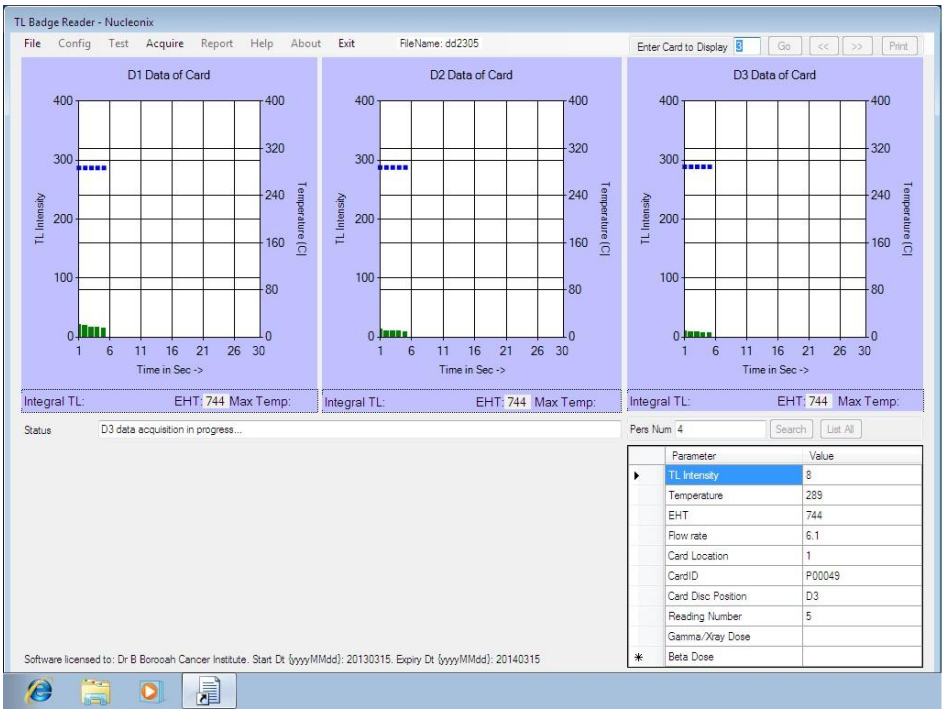
Check Heater

In this check, the Heater is turned ON and the time in which it attains the Set temperature is recorded. The flow rate should be set > 5 lpm to ensure overheating of Nichrome Heater assembly is prevented. The duration in which Set temperature is attained is displayed. In case Set temperature is not attained, then Flow rate and Heater settings have to be verified

Note: At this time user must confirm the flow rate is set or not

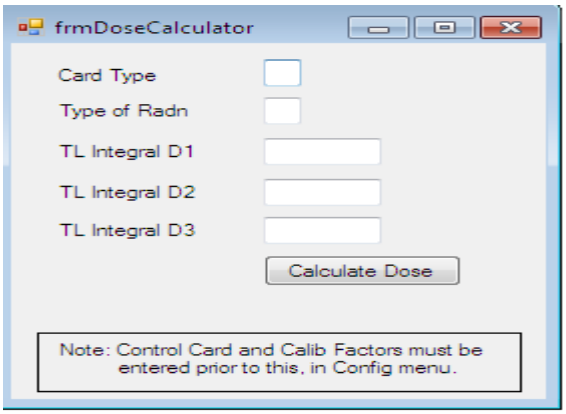


Test mode for 5 sec: This mode is for checking Heater, magazine move movements and disc positioning for 50 cards



Dose Calculator

Dose Calculator is provided to manually calculate Dose values by entering Card type (W/C/B/E for Worker or Control or Blank or Exposed), Type of Radiation (G/B/X for Gamma or Beta or X-ray), TL Integral values for D1, D2, D3 positions.


frmDoseCalculator
Card Type
Type of Radn
TL Integral D1
TL Integral D2
TL Integral D3
Calculate Dose
Note: Control Card and Calib Factors must be entered prior to this, in Config menu.

6.2.3 ACQUIRE MENU

Prepare Reader for Acquisition

Prior to acquisition, Tests can be individually done using commands in “Test” menu. Alternatively, user can click on “Acquire” menu and “Prepare reader for acquisition” to conduct various tests in sequence. The following operations are done in sequence when this command is given: Dark Current Mode check, Adjust Flow rate, Heater check and
Light Source Mode Check. Followed by Light source check, Magazine will be ejected out for removal of Light Source TLD Card
When the command **‘Prepare Reader for Acquisition’** is clicked,

During Dark current check, EHT check and PMT Dark counts are checked. Incase EHT is faulty failure messages will be shown

During Flow Rate Check, PC prompts user to adjust flow rate in the range of 5-6 lpm using the needle valve provided on the digital flow meter. Once it is set, press OK button. This will initiate Heater check automatically

During Heater Check, the current ADC value corresponding to current temperature is displayed. Once the current ADC reaches limit ADC value, temperature check is terminated and the time elapsed for reaching the limit ADC value is shown. This will be corresponding to the final set Temperature. The final temperature is reached within 20-25 seconds if solenoid / heater / flow meter are working properly otherwise failure message is prompted

During Light source check mechanical movements are tested partially and PMT gain stability can be verified. In the event of any mechanical failure light source check is terminated and suitable message is prompted

Start

Having performed all the Hardware Tests and ensuring the settings are at desirable values, User is ready to start acquisition. Clicking on “Start” will display the below message:
Will acquire for “n” cards. “n” is the number of Cards entered in Card Details window. User is now asked to enter the Card number from which to start acquiring the data. User can enter “1”. In case User is resuming acquisition after “Stopping” to enter Control cards data or for any other reason, then the appropriate Card number can be entered.
User is then asked to enter the Filename to Save spectrum data.
The acquisition starts and continues for all the Cards. Spectrum Data for each card is viewed by an option in “File” option tends spectra files ,Dump texts can also viewed by “text file” option in “File” option. Opened text files can save by “Save” option in “File” option

Note: User must not perform any other operations in this application while acquisition is on. Also, no other application must be run in the background during this time. Doing this might disturb the plot.

Stop

This command is useful to Stop acquisition either for Setting Control Card values or any other reason. The acquisition will stop after acquiring for all 3 Disc positions. To resume after stopping, User must click on “Start” again and enter the next Card position from which acquisition must resume.

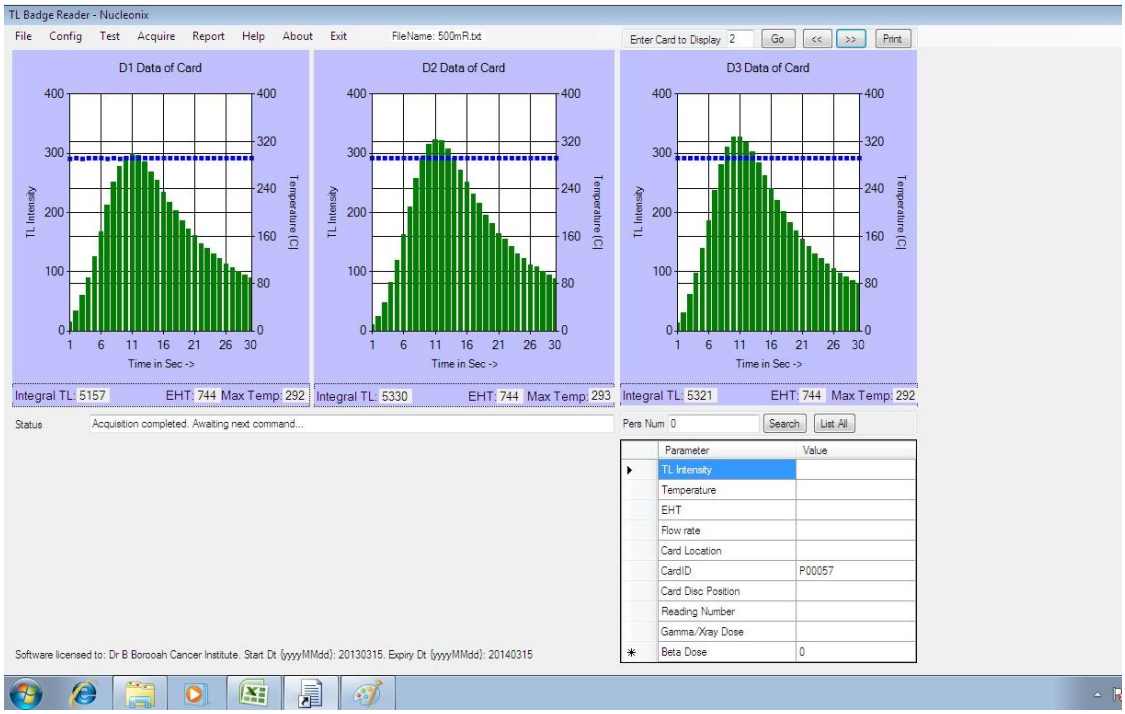
Eject

This command can be used to Eject the Magazine.

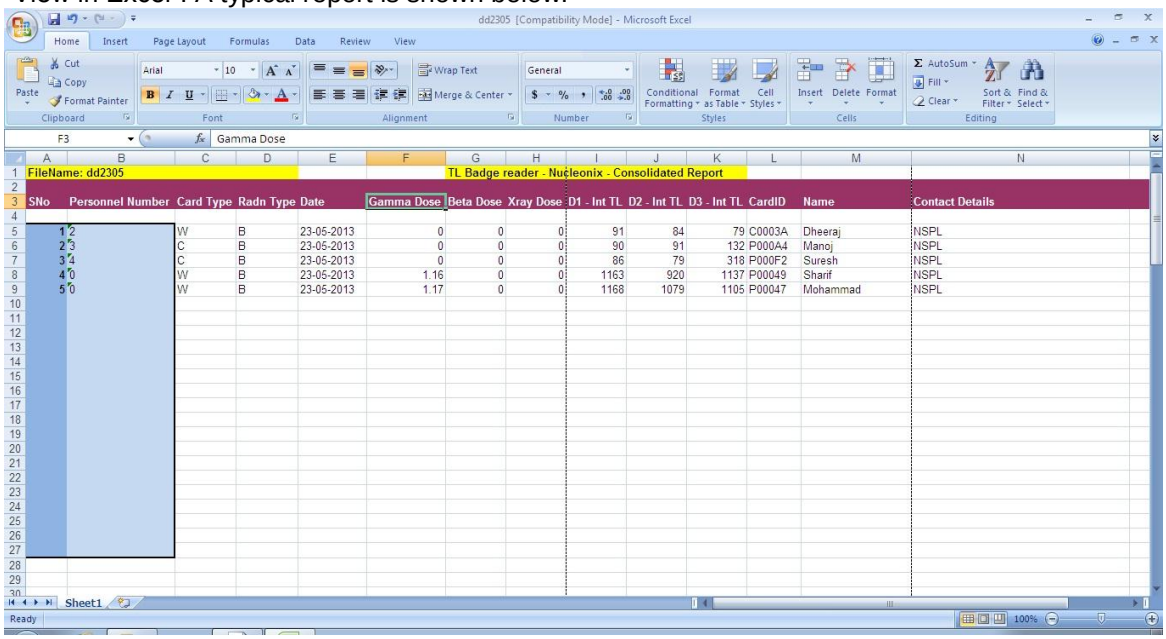
6.2.4 FILE AND REPORT MENUS

Viewing Saved Spectra

Saved Spectra can be viewed in TLBadgeReader application or in Excel. To view in application, click on “File” Menu and “Open”. Select the filename to open and click ok.
The spectra are retrieved into Memory. To view the spectra, enter the card number in the textbox next to “Go” button and click on “Go” button. To maneuver, use the “Next” and “Prev” buttons. Personnel number and Dose details are displayed in the Grid at bottom right.
A sample is shown below:

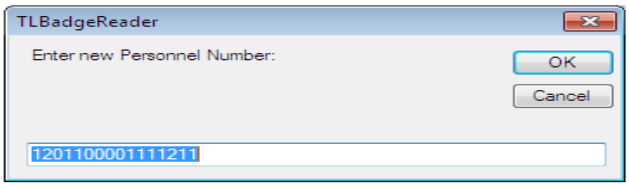


Saved Spectra can also be viewed in Excel. This can be done by clicking on “Report” menu and “View in Excel”. A typical report is shown below:

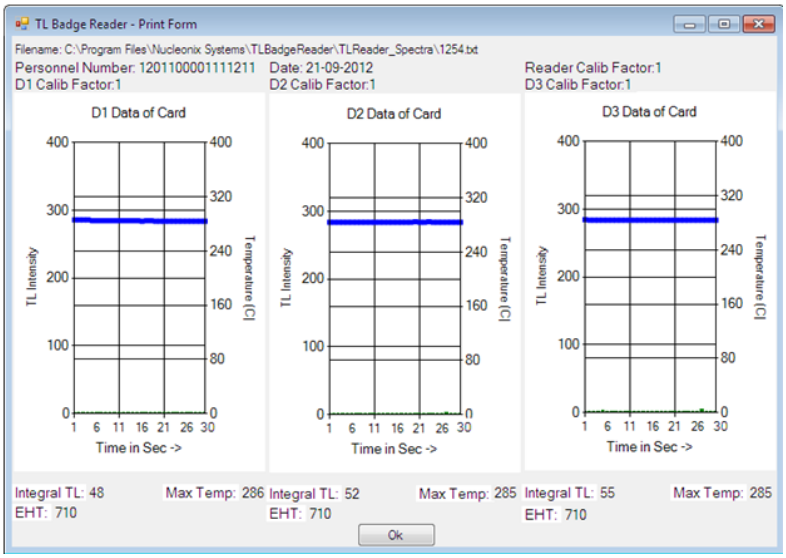

dd2305 [Compatibility Mode] - Microsoft Excel
Gamma Dose
FileName: dd2305
TL Badge reader - Nucleonix - Consolidated Report
SNo Personnel Number Card Type Radn Type Date Gamma Dose Beta Dose Xray Dose D1 - Int TL D2 - Int TL D3 - Int TL CardID Name Contact Details
1 2 W B 23-05-2013 0 0 0 91 84 79 C0003A Dheeraj NSPL
2 3 C B 23-05-2013 0 0 0 90 91 132 P000A4 Manoj NSPL
3 4 C B 23-05-2013 0 0 0 86 79 318 P000F2 Suresh NSPL
4 0 W B 23-05-2013 1.16 0 0 1163 920 1137 P00049 Sharif NSPL
5 0 W B 23-05-2013 1.17 0 0 1168 1079 1105 P00047 Mohammad NSPL
Sheet1
Ready

This is a comprehensive report with all details related to the card ID. Personnel number, Card Type, Radn Type, Date, Dose value, D1, D2, D3, Int TLD, Person name and contact details are displayed.

Editing of saved person details:
Editing of Personnel number can also do by this way as shown,
Click on that number below window will appear edit as required and Click OK



Printing of Spectra file:
Printing of spectra file can be done by loading that file and click on the print option top of the window, window will appear as below and Click Ok to print



6.2.5 HELP

Operating procedures & specific help can be obtained by checking on help menu

6.2.6 ABOUT THIS SOFTWARE

The version number of this software is displayed when “About“ menu is clicked. Please check with Nucleonix for the latest upgrades.

Maintenance and Customer Support
Periodic functional checks of system must be performed whenever possible. This can be done by Customer’s trained employees. Apart from this, PC must be kept free from Virus and backed up by UPS power.
Customer must enter into Annual Maintenance Contract after Warranty. This will entitle them for preventive maintenance checks, software upgrades, Re-Calibration, etc.
In case of any queries or issues with the software, you may contact us by email / phone / letter / fax. Details are given below:
Customer Support Department

Nucleonix Systems P Ltd
Plot 162 A&B, IDA, Phase-2, Cherlapally,
Hyderabad, INDIA. Pin: 5000051
Ph: +91-40-27263701, Fax: +91-40-27262146
Email: info@nucleonix.com, Web: www.nucleonix.com

CHAPTER – VII

GENERAL GUIDELINES FOR USE OF TLD BADGE READER

Temperature & N_2 Gas Flow Rate Adjustments: The life & reusability of the dosimeters critically depend on the maximum temperature to which the dosimeter is subjected to while reading the dosimeter. Hence the following precautions are to be observed while adjusting these parameters.

Flow Rate: The flow rate should not exceed 6LPM and the inlet pressure of the gas should be adjusted to 2 Kg/cm^2.

Temperature Adjustment: The optimum maximum temperature will be the one that corresponds to a left-out TL (i.e., the TL output from the dosimeter in a subsequent readout) of the order of 10%. Too large a left-out TL would mean insufficient heating and too less a left-out TL indicates over heating. Over heating, apart from reducing the life of the dosimeter, results in deformation of the Teflon based dosimeter. The deformed dosimeter often causes jamming of the card carrier mechanism in the Reader.

The temperature can be adjusted, if necessary, with the potentiometer P3 on the temperature controller PCB using the 'Heater Check' from the Test Menu of the TL Badge Reader software. If any adjustment of temperature is made, the ADC value corresponding to the temperature set point reading on the PC should be stored as the Temperature Limit Value in Settings Text File. This is necessary as the computer waits for the heater to stabilize to the ADC value corresponding to the Temperature Limit value

Waiting period for temperature to stabilize: At the initiation of the start command, the system opens the solenoid valve for the gas, starts the heating cycle and waits for the temperature of the gas to reach 285^oC before starting the readout cycle. The waiting period is about 1-2 minutes depending on the ambient conditions. If it exceeds 2 minutes then heater failure is prompted by the PC and the temperature controller may need adjustment or could be faulty. Flow rate should not be unduly increased beyond 6 LPM as it is likely to deform the dosimeters.

When the temperature reaches 285^oC, the readout process starts within 1 or 2 seconds delay. A readout time per dosimeter is 30 seconds and the 50 cards are read in about 100 minutes. The readings are stored in the database at the end of readout of each card

Calibration: The reader can be calibrated using a calibration factor which is entered manually at the time of starting the readout or by varying the EHT which in turn varies the gain of the PMT. However, in the reader an optimum EHT for the PMT used has been selected (600 – 800V) to obtain the best signal-to-noise ratio in the light collection system. Hence the user is advised to use the calibration factor to calibrate the reader.

The calibration factor can be obtained using 10 or more cards exposed to a uniform dose of 5 mSv and reading them in the reader using the above procedure. After the readout is over, 'S' (Statistical analysis) option in the tool bar can be used to evaluate dose. The software has a provision to exclude readings, which have a large deviation from the mean. The calibration factor is then the ratio of the actual dose given to the cards to the mean dose.

CHAPTER - VIII

DOSE EVALUATION

Dose evaluation is carried out using some empirical relations which have been arrived at after thorough experimental work. Usually a minimum reporting value (RV) is decided on the basis of the uncertainties in the dose evaluation process including those inherent in the basic dosimetry. After calculation of the dose, if the computed value is less than the RV (default values is 0.2 mSv), dose is reported as zero.

A 16 digit ID code is used for the personnel number. The first 4 digits are assigned for the Institution to which the person belongs. The last four digits are the personal ID number of the person. The middle four digits are to indicate the service month (two digits, 1 to 12), frequency of service (one digit, 1 for monthly, 2 for bimonthly & so on) and the nature of radiation environment (one digit, 1 for gamma, 1 for beta / gamma, 2 for X rays / gamma and 4 for diagnostic X-rays) in which the person works. The dose evaluation software evaluates the dose depending on the code entered as per the following relation:

Keys to abbreviation:
D1 : Reading of dosimeter under Cu-Al filter.
D2 : Reading of dosimeter under plastic window.
D3 : Reading of dosimeter under open window.
RV : Reporting value. Default value is 0.2 mSv. User selectable.
CR21 : Ratio of D2 reading to D1 reading when exposed to calibration dose. (Default Value 1.1)
CR31 : Ratio of D3 reading to D1 reading when exposed to calibration dose. (Default Value 1.15)

Empirical constants:
A1 = 2.6017, A2 = -15.8861, A3 = 45.5412, A4 = -53.2834, A5 = 22.612.
D1', D2', D3' are D1, D2, D3, minus the control card reading. D1' D2' D3' are equated to zero if less than zero.
Depending on the nature of the radiation (user selected) one of the following four equations are used.

Gamma :
Gamma dose = D1' (equated to zero if less than RV)

Beta – Gamma :
Gamma dose = D1' (equated to zero if less than RV)
Beta dose = BMF X (D3'-CR31 X D1')
= zero if less than RV.
Where
BMF (Beta Modification Factor) = 1.397437 + 0.2002848 x K1
Where
K1 = (D3 – CR31 X D1') / K
Where
K = D2 – CR21 X D1 (If K < 20, then K = 20)

X – Gamma :
If D1' or D2' or D3' <5, then D1' or D2' or D3' = 5
R12 = D1' / D2'
If R12 $\geq$ 0.7 then Dose = D1' (If less than RV equate to zero)
Else Dose = D1' X ($A1 + R12 \times A2 + R12 \times A3^2 + R12 \times A4^3 + R12 \times A5^4$)
(Equate to zero if less than RV)

Diagnostic X- Rays:
If D1' / D2' < 5 then dose is evaluated as above.
If D1' / D2 $\geq$ 5 then
Dose = (D2' + D3') / 20 with the following message

Badge worn over lead apron or lead apron not used.

CHAPTER - IX

DOSE DATA MANAGEMENT

When the dose evaluation software is executed four files are generated or appended (if already existing). Two files 'RED.DAT' & 'RD.DAT' in the format given below are created as a fresh, every time the dose evaluation software is executed. Both these files are used as a temporary input files during the dose evaluation routine.

File format of temporary files rd.dat & red.dat.

9906100620010001	00007547	00064086	00053152
9906100620010011	00007407	00063076	00063151
9906100620010021	00007443	00074086	00059959
9906100620010031	00006678	00068089	00063758

The third file generated is the "PERS.DAT" file which contains the entire dose readout details such as the 16-digit personnel number, the three dosimeter readings and the evaluated dose. A typical PERS.DAT file format is shown below.

Inst No.	Pers No.	Serv Mon.	Serv Yr	Serv Freq	Loc code	Disc-1	Disc-2	Disc-3	Gamma mSv	Beta mSv
000011	1200	01	99	1	0	00007547	00064086	00053152	7.5	
000011	1201	01	99	1	1	00007895	00077920	0007986	7.9	
000011	1201	01	99	1	1	00000658	00000621	00000593	0.6	
000011	1202	01	99	1	2	00000548	00000520	00000507	0.5	0.0
000011	1203	01	99	1	3	00000464	00000464	00000441	0.5	
000011	1204	01	99	1	3	00000385	00000376	00000357	0.4	
000011	1205	01	99	1	0	00000386	00000456	00000645	0.4	

The fourth file generated is the "DOSE.DAT" file that contains just the personnel number and the evaluated dose. The following is a typical DOSE.DAT file. This file gets appended every time the dose evaluation is done for a set of cards. This file is called in the 'Print dose report' option. The format of the 'dose.dat' file is shown below.

0000110110120096	7.5	
0000110111120196	7.9	
0000110111120196	0.6	
0000110112120296	0.5	0.0
0000110113120396	0.5	
0000110113120496	0.4	

THE DOSE REPORT FILE "DOSE.REP" :

This file is created (appended if already exists) when the "Print Dose Report" option is invoked from the print menu. During this operation, three files **'DOSE.DAT'** (generated in the dose evaluation menu). **"INSTIT.FLE & PERSN.FLE"** (generated using the "Create File" utility) are used. The Institution name, address and the personnel name are obtained using the appropriate codes in the 16-digit personnel identification code. The dose stored against this personnel identification code in the 'dose.dat' file is printed and also stored in the "DOSE.REF" file. During the process a temporary file 'IPSN' is created in the current working directory. A typical dose report print-out is shown below.

Dose report

INST. CODE : 0011
ADDRESS : Bhabha Atomic Research Centre
RPIS, RPhD
Mood Labs, Trombay
Bombay, PIN : 400 085

Pers. No.	Name	Month / Year	Radia. Field	Dose (mSv) Whole Body	Skin	Remarks
1200	Mr. S.J. Gandhi	01/96	Gamma	7.5	0.0	
1201	Ms. P.T. Jain	01/96	X-Gma	7.9		
1201	Ms. P.K jadhav	01/96	X-Gma	0.6		
1202	Mr. C.M. Katoch	01/96	Bt-Gm	0.5		
1203	Mr. D. Suresh	01/96	Dia-X	0.5		
1204	Mr. M.R. Patil	01/96	Dia_x	0.4		
1205	Mr. K.R. Nair	01/96	Gamma	0.4		

A file named “DREP.MSG” stored as a text file in the current working directory is accessed at the end of “Print Dose Report” routine. This file is to be created by the user in the dos edit mode. The contents of this file will be printed at the end of the dose report. In this file the user can store any message, note, user identity etc. which he would like to be printed at the end of the dose report.
These files can be used with appropriate software packages for updating & maintaining the dose records of the personnel.

CHAPTER - X
REUSE OF DOSIMETERS

There is a 10% left over TL after the 30 sec readout in the reader. The cards, therefore, are required to be annealed before reuse as per the following procedure.

TLD cards are first cleaned in acetone to remove grease, dust particles, if any, sticking to the dosimeter discs. This done by keeping the cards immersed in acetone container for about an hour. Thereafter, acetone is removed by pouring out into another container. The cards are kept overnight in the container so as to completely remove traces of acetone. These cleaned cards are transferred to a stainless steel tray and introduced into a programmable temperature oven with air circulation. The oven is then switched on and the temperature of the oven is raised to 230°C +/-2^{o}C in about 60 minutes. The temperature is maintained at 230°C for 3 hours and then the oven is allowed to cool to less than 50°C. The cards are then taken out and are ready for reuse.

CHAPTER - XI

TROUBLE SHOOTING

In case of any failure in instrument during acquisition, that failure will reflect in LCD display of Instrument as below Failure Code format and a failure message will appear in software

FAILURE CODE ON LCD DISPLAY	SOFTWARE MESSAGE
CRF	Card rise Failure
CLF	Card lower Failure
CPHF	Card Home Failure
MHF	Magazine Home Failure
S0F	Shutter Open Failure
SCF	Shutter Close Failure
MPF (n=1 to 50)	Magazine position n Failure (n=1to 50)
CP1F	Card position 1 Failure
CP2F	Card position 2 Failure
CP3F	Card position 3 Failure
TEMPF	Temperature controller Failure
FLOF	Flow Failure
EHTF	EHT Failure
:T1#F!	Temperature / Gas flow failure
F CODE	Code Error
N CODE	No card

FAULT DIAGNOSIS

Nature of Problem	Remedy
Door open	Close the door tightly until LED goes OFF on front panel. Check using Command Prompt by entering ":MD#". Response should be ":MD#0!" when door is Closed
Magazine home Failure	Check by entering ":MH#" in command prompt ,its response should be ":MHO";Check whether magazine is moving or not , if not there may be problem in Magazine drive motor. Check all connections to the magazine motor. If magazine stops at wrong position ;there may be mismatch of position sensor arrangement, by adjusting that problem will be resolved
Card lower Failure	Check by Entering ":cDL#" ; its response should be "CLO" ,if not ,check all connections of Card raise/lower sensor PCB and Z-motor .
Card raise Failure	Check by entering ":cDR#" in command prompt, its response should be "CRO" ,if not ,check all connections of Card raise/lower sensor PCB and Z-motor .
Card Home Position Failure	Check by entering ":cSH#" in command prompt , its response should be "CPHO";if not check all connections of Card home position sensor PCB
Card Position n failure n=1 to 3	Check by entering ":cS1#" / "cS2#" / "cS3#" in command prompt. Its response should be "CP1O" / "CP2O" / "CP3O" ";if not check all connections of Disc position sensor PCB
Magazine position n Failure ;n = 1 to 50	Check by entering ":mnn#"(n=1 to 50)in command prompt ,its response should be "MPnnO"; if not check position sensor arrangement
Shutter Open Failure	Check by entering ":s0#". Its response should be "SOO". If not check all connections of shutter control PCB and Shutter motor
Shutter Close Failure	Check by entering ":s1#". Its response should be "SCO". If not check all connections of shutter control PCB and Shutter motor
Flow rate Failure	Read Flow Rate by turning Solenoid ON. If it is not set properly then adjust and recheck Flow rate on display. Otherwise check connections Flow+ and Flow –
Temperature controller Failure	Check this by Heater check option in software or by entering ":T1#"and wait for 30 sec. Ensure flow rate is showing 6 LPM during acquisition. Now issue a fresh command ":T1#" and its response should ":T1#1400!". If not, check Temperature Controller board as given in temperature calibration.
EHT Failure	Measure EHT at MHV socket on Temperature controller / HV PCB cable. If it is not coming then there is a problem with EHT module. It needs repair / replacement

CHAPTER - XII

PRECAUTIONS

1. The light-tight compartment should be closed when the unit is in ON condition. If the upper cover is to be open in ON condition, remove the HV connector from PMT before switching the unit ON.

2. Removal of PMT from PMT housing should be done in a dark room only. (PMT is sensitive to light).

3. While readouts are in progress if Hardware Failure occurs due to mechanical failure then follow the below procedure.

    a. If the failure is mechanical in Nature, then switch OFF the TLD unit to prevent mechanical damage to channel / magazine. Next try to restore the jammed TLD Card first into its magazine slot and powering unit back ON. Card will automatically get lowered back into its slot in the magazine.

    b. Remove any / all deformed TLD Cards to prevent the magazine from getting stuck

    c. Reload the magazine and close the Reader dark chamber cover and Top hinged cover.

    d. Switch ON the system and read the remaining cards.

4. The channel should be regularly cleaned with cotton to remove dust & foreign particles.

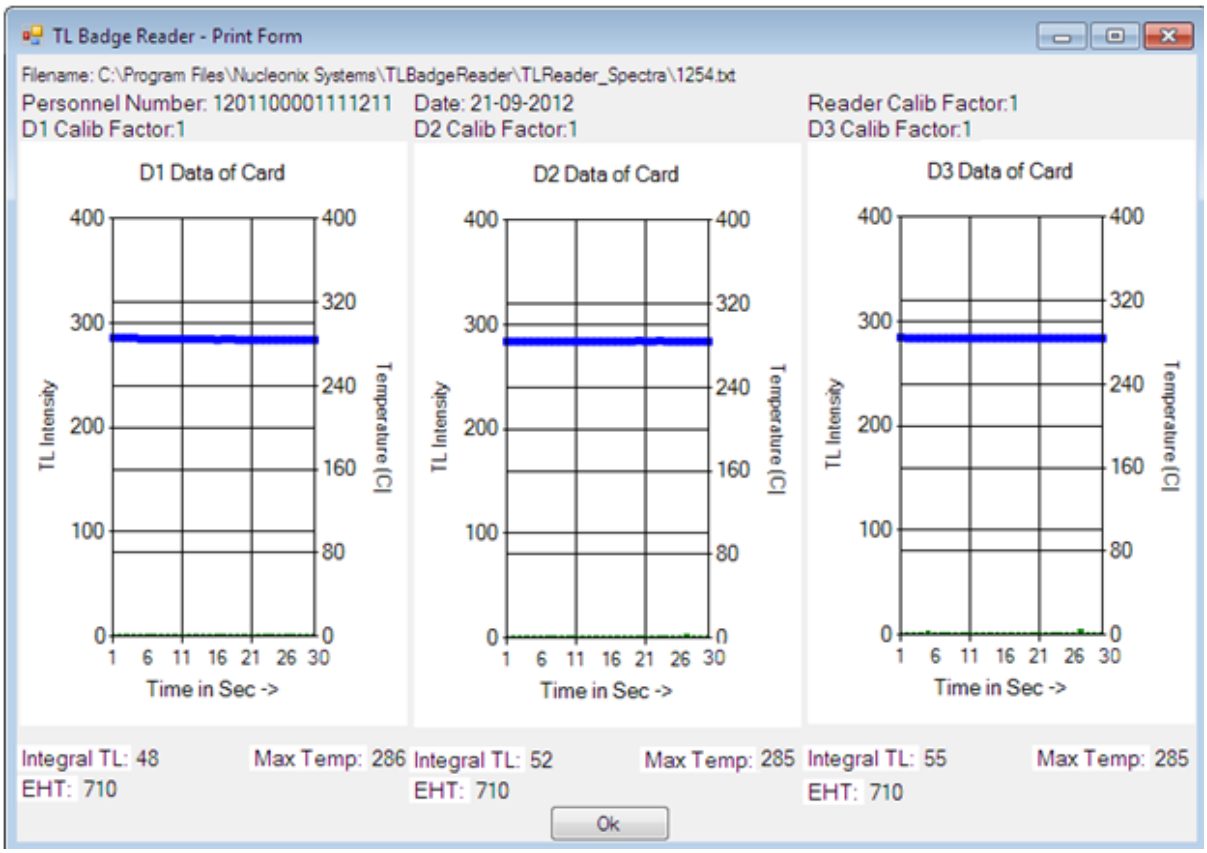
5. In case of communication error message, ensure correct COM port assignment in software & check for cable connectivity.

6. Check for the Door LED ON/OFF. When door is closed only RED LED has to glow. Door Open Error should get reported in software during Acquisition if door is opened

Important Note:
Ensure the light tight compartment & upper cover is in closed condition before switching it ON.

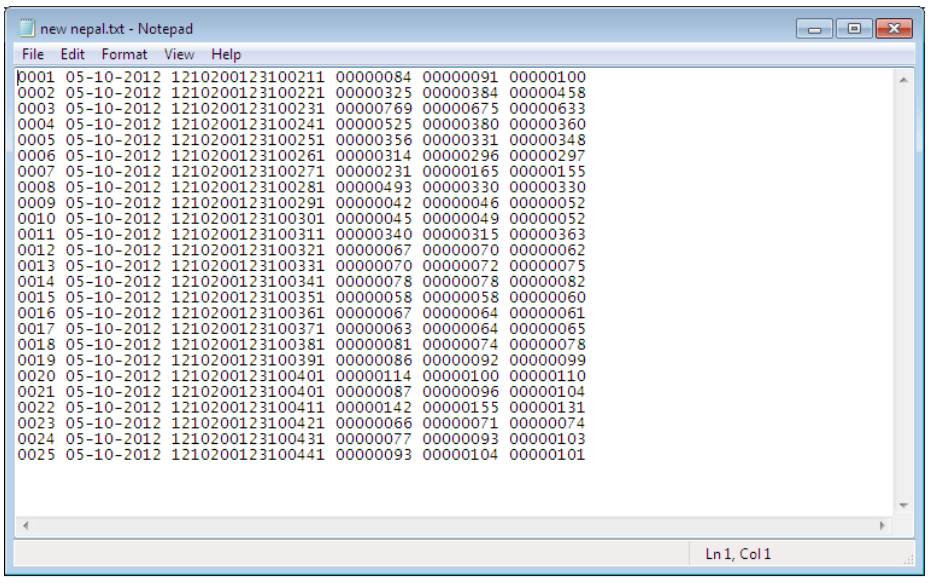
CHAPTER - XIII

SAMPLE GLOW CURVE



DUMP TEXT FILE

This can view directly from software “file “option tends “Open text file”



READOUT SHEET

Calibration Factor : 1.00

0003100000000010	D3	00000031	D2	00000057	D1	00000077
0003100000000020	D3	00000034	D2	00000097	D1	00000065
0003100000000030	D3	00000033	D2	00000052	D1	00000088
0003100000000040	D3	00000031	D2	00000094	D1	00000078
0003100000000050	D3	00000031	D2	00000082	D1	00000072
0003100000000060	D3	00000031	D2	00000045	D1	00000056
0003100000000070	D3	00000025	D2	00000065	D1	00000072
0003100000000080	D3	00000030	D2	00000056	D1	00000051
0003100000000090	D3	00000037	D2	00000074	D1	00000081
0003100000000100	D3	00000040	D2	00000081	D1	00000084
0003100000000110	D3	00000040	D2	00000084	D1	00000082
0003100000000120	D3	00000046	D2	00000085	D1	00000099
0003100000000130	D3	00000047	D2	00000076	D1	00000083
0003100000000140	D3	00000045	D2	00000079	D1	00000089
0003100000000150	D3	00000045	D2	00000095	D1	00000090
0003100000000160	D3	00000049	D2	00000117	D1	00000105
0003100000000170	D3	00000052	D2	00000102	D1	00000088
0003100000000180	D3	00000047	D2	00000078	D1	00000083
0003100000000190	D3	00000045	D2	00000092	D1	00000094
0003100000000200	D3	00000053	D2	00000104	D1	00000238
0003100000000210	D3	00000047	D2	00000081	D1	00000078
0003100000000220	D3	00000046	D2	00000082	D1	00000081
0003100000000230	D3	00000043	D2	00000091	D1	00000105
0003100000000240	D3	00000047	D2	00000081	D1	00000088
0003100000000250	D3	00000051	D2	00000088	D1	00000083
0003100000000260	D3	00000046	D2	00000074	D1	00000072
0003100000000270	D3	00000067	D2	00000106	D1	00000093
0003100000000280	D3	00000060	D2	00000082	D1	00000094
0003100000000290	D3	00000048	D2	00000077	D1	00000100
0003100000000300	D3	00000053	D2	00000090	D1	00000082
0003100000000310	D3	00000047	D2	00000088	D1	00000091
0003100000000320	D3	00000047	D2	00000088	D1	00000097
0003100000000330	D3	00000054	D2	00000076	D1	00000089
0003100000000340	D3	00000047	D2	00000090	D1	00000079
0003100000000350	D3	00000049	D2	00000092	D1	00000095
0003100000000360	D3	00000050	D2	00000081	D1	00000083
0003100000000370	D3	00000047	D2	00000096	D1	00000087
0003100000000380	D3	00000053	D2	00000085	D1	00000099
0003100000000390	D3	00000052	D2	00000086	D1	00000113
0003100000000400	D3	00000052	D2	00000099	D1	00000094
0003100000000410	D3	00000062	D2	00000102	D1	00000088
0003100000000420	D3	00000054	D2	00000108	D1	00000101
0003100000000430	D3	00000052	D2	00000082	D1	00000096
0003100000000440	D3	00000058	D2	00000087	D1	00000100
0003100000000450	D3	00000061	D2	00000088	D1	00000087
0003100000000460	D3	00000058	D2	00000076	D1	00000093
0003100000000470	D3	00000059	D2	00000136	D1	00000113
0003100000000480	D3	00000061	D2	00000102	D1	00000095
0003100000000490	D3	00000068	D2	00000088	D1	00000085
0003100000000500	D3	00000088	D2	00000118	D1	00000110

CHAPTER - XIV

TESTING OF TLD BADGE READER

1. Light Leakage : Check the readout of freshly annealed card in bright room as well as in the dark room.

2. EHT to PM Tube : After warm up time of 30 minutes, EHT should not vary by more than $\pm$1v throughout the read out process.

3. Light Source Reading : The repeated LS reading can be taken in the reader test mode. The light source reading should not vary by more than $\pm$ 5% throughout the day.

4. Read out temperature : The clamping temperature as per the display should be around 285^{o}C. $\pm$2^{o}C and should reach within 50-60s from the start of heating cycle. The flow rate of N_2 gas should be set in between 5-6 lpm. Changes in the flow rate may cause significant variation in the readout.

5. Glow Curve and Uniformity in Readout: Expose 10 (Selected) TLD cards sandwiched between perspex build-up plates (thickness 4-5 mm) to about 4-5mSv of Cs-137 gamma rays. TL readouts of all the cards should be taken and uniformity of gas heating can be checked by recording glow curves and comparing their stability.

6. Residual TL check : Second readout of the above cards should be taken to check the residual TL. The second readout should not be more than 10-12% of the first readout. If it is more either flow rate or air temperature point has to be adjusted.

7. Reproducibility of the TL Readout: For this test, atleast 10 selected TLD cards should be used. The cards are to be annealed, exposed in build-up plates and read after one day after the exposure. Cycle to cycle variation of average TL readout should be within $\pm$10% and incase of any significant change, the response should have an established trend. Minimum three cycles of annealing, exposure and readout has to be carried out.

8. Minimum Measurable Dose : The readout of some freshly annealed TLD cards (atleast 10 cards) should be taken. The minimum measurable dose can be obtained from the value of 2σ.

9. Linearity test : Expose freshly annealed cards (a minimum of 5 doses, 5 cards for each dose) in the dose range from 0.3mSv to 1Sv of Cs-137 gamma rays and readout of all cards should be taken in similar conditions. The TL response (average TL/mSv) should be within $\pm$ 10% in the entire dose range covered.

CHAPTER - XV

CALIBRATION OF TLD BADGE READER

1. Setting of TLD Reader: The TLD readers should be kept “ON” for atleast half an Hour for warm-up before starting the actual measurements on it. After LS measurements, readout of 2-3 dummy TLD cards should be taken to check the temperature and heating profile. Then take readout of three exposed calibration cards to confirm the calibration of the reader and if required either Reader Calibration Factor (RCF) should be changed or EHT to the PM tube should be adjusted to indicate the counts in desired proportion to dose (1µSv – 1count).
2. Intermittent check of TLD Reader Sensitivity: The reading of ^{63}Ni light source TLD Card & Calibration Cards can be taken intermittently in a day.

N O T E

CAUTION : Do not open light compartments in unit “ON” condition.

Incase of any Hardware failure while taking readouts, follow the below procedure

1. If the failure is mechanical in Nature, try to restore the jammed TLD Card first in its magazine slot by powering the unit OFF and powering it back ON. If the deformation on the Card is removed then the card will automatically go back into its slot.
2. Remove any / all deformed TLD Cards to prevent the magazine from getting stuck
3. Reload the magazine and close the Reader dark chamber cover and Top hinged cover.
4. Switch ON the system and read the remaining cards.

CHAPTER – XVI

AVAILING OF MAINTENANCE/ CALIBRATION SERVICES AND WARRANTY CLAUSE (with in India)

16.1 GENERAL

As per the warranty clause of the company, we provide one year warranty during which period we provide free service at our works. Hence in case of any mal-function in our instruments, you are requested to send the unit back to our works by RPP/COURIER/SPEED POST PARCEL/GATI/XPS/door delivery. We shall arrange immediate rectification/replacement within two weeks from the date of receipt of the equipment at our place. Please note that the equipment will be serviced at our works only.

The equipment is to be sent to:

The Servicing Department
NUCLEONIX SYSTEMS PRIVATE LIMITED
Plot No: 162 A & B, PHASE II, I.D.A. Cherlapally,
Hyderabad - 500 051Ph: 040-27263701/329145448/32918055
E-mail: info@nucleonix.com www.nucleonix.com

For all the Radiation monitoring equipment, detectors built-in or external probes will not have one-year warranty, but only inspection warranty at the time of supply is provided. Since detectors will / may have fragile glass construction, we do not provide warranty. In case of failure of these components, Nucleonix will supply detector replacement at cost-cost price.

Note: In respect of all types of portable radiation monitors, it may be necessary to checkup and recalibrate the equipment once a year at our works.

16.2 EQUIPMENT REPAIRS / SERVICING POLICY (WITH IN INDIA)

(a) During Warrantee

The following procedure is to be followed by the customers with in India for availing services/ repairing facility during warrantee period.

- Equipments are to be sent to our works for availing free repair services during warrantee, after the customer receives approval from the customer support division, by sending an e-mail.
- For all equipments, costing less than 6.0 lakhs one year warrantee & free service is offered, when the equipments are sent to our works only. For larger systems such as installed systems, networked systems, specialized systems, costing more than 6.0 lakhs during one year warrantee, free service is offered at site. Field service Engineer will be deputed subject to warrantee terms & conditions.
- This does not include personal computer related problems, for which local computer service provider of the PC vendor is to be contacted. Also for software related problems online support will be provided. Software support doesn't include cleaning of virus problems etc.
- When the equipments are sent to our works for warrantee services, they are to be properly packed with adequate cushion to prevent any transportation damages. Nucleonix Systems is not responsible for damages or loss during transportation.
- Packing / Freight charge is to be borne by customer when he sends the equipment to our works. However when we return after servicing packing will be Nucleonix responsibility & Freight charges will be to your account. Only services are free.
- Please indicate in your correspondence equipment model & serial number.
- All the equipments are to be sent to our works only on door delivery basis.
- For Door Delivery Transportation contact XPS/GATI cargo in your city / town or a reliable courier service to pick the consignment from your place. For their nearest local address & phone no's look into their websites. Transit insurance if the customer feels is necessary it is to be covered.

- Nucleonix Systems will not receive the equipments sent by other modes of transportation, such as Rail/Road.
- After servicing, equipments will be sent back by same mode of transport such as XPS/GATI/COURIER/RPP.
- All types of Radiation detectors, glass ware, PMTs etc which are fragile are not covered in warrantee, if the failure is due to physical damage, external or internal due to shock, dropping, miss-handling etc. If the failure is due to a natural fault then only it is covered under warrantee for a limited period of three months. However complete electronics is covered for 1 year warrantee.
- You can also send the equipment personally to our works for repairs either during or after warrantee, after fixing up with our service dept (Customer Support Division). If possible we may repair on same day or your person can stay for a day or two & get it repaired & or calibrated.

(b) After warrantee Services

- On expiry of 1yr warrantee if you like to send the equipment (low cost less than 6.0 lakhs) for repairs to our works, you may please observe the following procedure.
- Send an e-mail with details mentioning that you agree to pay service charges which includes: Basic service charges per unit / module in the range of Rs: 2500 to Rs : 10,000 depending on the sophistication of the unit calibration charges (if applicable for your equipment) + cost of components + packing charges + Return Freight charges @ actual.
- Once our customer support department responds & requests you to despatch the equipment to our works for repairs, you may do so by following the steps given below.
- Followed by this you can send the equipment straight away if it is within 5 yrs old. If the equipment is beyond 5 yrs old, then also you can send it for repairs, however only after you receive confirmation from Customer Support Division, that it is repairable & is not an obsolete model. If the design is obsolete then customer support division (CSD) may give you 'buy back' offer to replace with new model or upgrade it with electronic circuit boards & enclosure.
- For all installed equipments costing above Rs: 6.0 lakhs which are larger in size & for which field servicing only is recommended, you can obtain a quotation with relevant details by sending an e-mail & avail the services accordingly.
- For all field servicing jobs, since we need to depute engineers, it is likely, to take time & also it will cost more which includes Engineer's TA & DA etc., apart from basic service charges + cost of spares etc. Please note that basic service charges will be different for different products depending upon sophistication.
- Also in some cases it may not be possible to fix-up the problems in the field itself, in such cases we may advise you to send them to our works.
- For all jobs to be serviced in the field, customer is requested to provide adequate details on the nature of problems, to enable our engineer to come prepared with adequate spares.
- For any additional information send an e-mail to info@nucleonix.com, Atten: Customer support division.

16.3 EQUIPMENT REPAIRS / SERVICING POLICY (FOR EXPORTS)

Equipments, manufactured & exported are subjected to a well defined quality assurance (QA) plan & Factory acceptance tests (FAT). Nucleonix systems has the following policy to provide maintenance support to overseas customers either directly or through international dealers / distributors.

(a) During & after warranty:

- For minor problems, which can be handled by customers, servicing tips have been provided in the user manual / servicing manual.
- Also most of the equipments have built-in fault diagnostic features which will indicate to the user nature of problem in the equipment. Based on the visual indication in the instrument Display, user can take corrective action or contact Nucleonix systems by email for help.
- Nucleonix systems will guide in localizing the defective part / module or sub-system by interacting with the customer if required. Skype will be used for communication.

- During warranty free replacement of sub-system or board (PCB) will be done. However customer has to send defective sub-system back to Nucleonix system with-in 15 days on arranging replacement.
- During & after warranty, any Freight charges & customs clearance charges are to be borne by customers, both ways.
- If it is a manufacturing defect, then Nucleonix system will bear the replacement cost of sub-system / unit. However any Freight charges & customs clearance charges in their country are to be borne by customer.
- After warranty, services will be similar to that of services during warranty. However, customer will have to pay for cost of parts replaced, freight charges both ways & customs clearance charges in both the countries. Nucleonix systems plans to introduce audio visuals on web or on CDs to facilitate product demonstration, installation & minor maintenance very soon.

16.4 HOW TO AVAIL CALIBRATION SERVICES (FOR INDIAN CUSTOMERS)

Nucleonix Systems offers radiation calibration services to its customers. Calibration services are provided for Nucleonix Systems manufactured products only, in general, as a company policy.

How to avail calibration services:

It is best advised that each of the Radiation monitors including Area monitors are calibrated once in a year. When you want to send your Radiation monitor / Area monitor / Contamination monitor for calibration to our works. You may send the equipment for calibration, by following the steps given below:

1. Our standard calibration charges per equipment (All types of Radiation monitors including portable survey meters, contamination monitors & Area Gamma Monitors) are Rs: 2500 + Packing + Freight charges. You can email a 'work order' accepting these charges.
2. Email your work order and despatch / send the equipment to our works if it is 5 years old or less including details of mode of transport sent with docket particulars.
3. Also mention in your work order & clearly indicate that you will agree to pay calibration charges & also equipment repair charges additionally if the unit is faulty & requires repairs before one can take it up for calibration.
4. You are requested to ensure good packing to avoid any transportation damages. Especially if there are external detector probes, they are to be packed with sufficient soft foam to ensure no damage in transportation.
5. Use only the specified following mode of transportation system for dispatching on door delivery basis. XPS/GATI cargo / Courier/RPP/Speed Post parcel etc. Send the equipment on freight paid basis. (Equipments sent by other methods such as Rail/Road etc will not be collected). Also you can cover for transit insurance both ways if you wish. Nucleonix system is not responsible for any transportation damages or loss during transportation both ways.
6. Immediately on receipt of the equipment, we will send an acknowledgement & also a proforma bill by email/ post.
7. Based on the proforma bill, once we receive the payment, equipment will be dispatched back by similar mode of transportation as mentioned above.

16.5 HOW TO AVAIL CALIBRATION SERVICES (FOR FOREIGN CUSTOMERS)

Foreign customers can calibrate Nucleonix make Radiation monitors/equipments in their country at any of their accredited Radiation calibration labs. Nucleonix systems will be happy to provide any help and guidance if needed, for calibration. Alternatively if you send the equipment here to India we can also provide calibration services.

Calibration Standards Lab & Facility:
We have two calibration labs.

i. Low Level Calibration Lab.
ii. High Dose Rate Calibration lab.

Low Level Calibration Lab: This has a Cs-137, 165 mci standard. "Gamma Survey Instruments Calibrator" from Amersham.
This calibration service has NIST Traceability standard. Calibration of all portable radiation monitors, survey meters, contamination monitors, Area monitors etc., is carried out in this lab upto 1 R/hr max dose rates.

Gamma Survey instruments calibrator has Cs-137 source 161.5 mCi as on 05 Aug 2002. It is basically a gamma survey instruments calibrator procured from AEA Technologies UK/USA. Has NIST traceability accuracy within +/_ 7%

High Dose Rate Calibration Lab: This lab has a 8 Ci, Co-60 standard housed in a CRC-2 camera, operated remotely viewed through CCTV arrangement. High dose rate survey meters, High level Area monitors etc are calibrated in this lab. This CRC-2 camera is housed in a separate concrete building. All the radiation monitors manufactured by Nucleonix Systems are authentically calibrated at this facility, before they are shipped / dispatched.

CRC-2 camera has Co-60 standard obtained from Bhabha Atomic Research Centre, Mumbai. It is a certified source.

16.5 ANNUAL MAINTENANCE CONTRACT (AMC)

Annual maintenance contract (AMC) services:

For all sophisticated instruments & systems and also for installed monitors & networked systems in a nuclear facility or a Radiological lab or in a Medical cyclotron facility where no. of instruments are networked, it is advised that customer enters into an economical Annual maintenance contract with Nucleonix system.

Detailed AMC proposal can be obtained from our customer support division (CSD), by giving required inputs.

Inputs required by our CSD to send you AMC proposal:

- Name, year & data of purchase, Sl. Nos. of equipments, Model No's, No. of equipments for which AMC is required. Additionally no. of calls per annum required for preventive & breakdown maintenance may also be indicated.

Advantage of entering into AMC:

- Equipment services offered will be prompt & timely
- Nucleonix systems maintain required spares, spare tested PCBs, detectors & other critical components which may become obsolete.
- Obsolescence in electrons is quite rapid. If you enter into AMC guaranteed service for the period of AMC will be the responsibility of Nucleonix Systems.
- Nucleonix Systems will maintain Engineers at your disposal to attend to AMC calls on time
- Without AMC prompt service calls are not guaranteed.
- If some critical components become obsolete, then Nucleonix systems may request you to upgrade the product with new model or new electronics which may be expensive if you are not under AMC.

Training on maintenance / servicing:

- To a limited extent, we offer training on maintenance / repairs at our works to customers on chargeable basis. Details can be obtained from our customer support division, by customers who may require such services.

CHAPTER – XVII

FACTORY ACCEPTANCE TEST

REPORT

FOR

AUTOMATIC TLD BADGE READER
MODEL NO. : TL1010A

W/O:
DATE:
SL NO:

Customer Name & Address:

……..

……

NUCLEONIX SYSTEMS PRIVATE LIMITED
Plot No: 162 A & B, Phase II, I.D.A. Cherlapally, Hyderabad - 500 051.
Ph : 91-040-27263701, Fax : 27262146, e-mail : info@nucleonix.com

A) EHT Stability Test :

S.No	Date	EHT (V) (Display)	EHT (V) (Actual)
1.			
2.			
3.			
4.			
5.			

Percentage Variation < 0.05% : (Y / N)

B) Temperature Set Points Test :

During reader idiling (Heater set point)	:	(150mV <S.P<250)
During reader cycle (Heater set point)	:	(150mV <S.P<600)
Gas temperature (Air set point)	:	(270mV <S.P<315)
Heater temperature while idiling	:	(150^{o}C <T<200^{o}C)
Heater temperature during readout cycle	:	(400^{o}C <T<50^{o}C)
Overshoot	:	(< 2^{o} C)
Clamping temperature	:	(290^{o}C +/-5^{o}C)
Flow rate as indicated	:	(4Lpm <Flow Rate <6Lpm)

Test passed for Temperature set points : YES / NO

C) Light Source Stability Test :

S.No	Date	Light source
1		
2		
3		
4		
5		

Percentage variation within +/- 5% : (Y / N)

Tested by : **Witnessed by :**

D) Mechanical movements :

1. Reliability test of mechanical movements (50 cycles with zero failures)
   a. Shutter motor control : OK / Fail
   b. Card raise / lower motor control : OK / Fail
   c. Magazine positioning test for 50 positions : OK / Fail
   d. Card transport motor control (Home, D1, D2 and D3) : OK / Fail
2. Solenoid operation test

Test passed for Mechanical movements : YES / NO

E) Annealed Card Readings :

EHT: Calibration factor: 1.00

Readings of ten freshly annealed cards

S.No	Card code ID	Readings		
		D1	D2	D3
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
Average				

Mean annealed card reading (<100μSv) :

Stdev :

% Stdev :

Tested by : **Witnessed by :**

F) Dosimetry Test

Adjust EHT = Calibration factor = 1.00

Readings of TLD cards uniformly exposed to 300mR to (Cs-137)

S.No	Card code ID	Readings			Average
		D1	D2	D3	
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

The average observed readings should be within +/-10% of the expected readings

G) Linearity Test

S.No	Card code ID	Exposed dose (mR)	Readings			Average
1		100				
2						
3						
4		200				
5						
6						
7		300				
8						
9						
10		400				
11						
12						
13		500				
14						
15						

The average observed readings for the various doses of exposure in the range of 100 to 500mR are within +/- 10% of the expected readings

Tested by : **Witnessed by :**

Instrument functional as per Technical Specifications : (OK / NOT OK)

Instrument Type : Automatic TLD Badge Reader

Model : TL1010A

S.No. :

Remarks

Tested By : **Witnessed By :**